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~~Effects of~~ ^{and} Low Dietary Iodine Intake ~~on~~ the Functional
Activity of the Rat Thyroid^{1,2}

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Abstract

The effects of low dietary iodine intake on the functional activity of the thyroid were studied in young female albino rats. Experiments were conducted with two low iodine diets containing less than 0.05 and 0.06 ppm iodine, with casein as the primary protein source. Feeding these diets to rats for periods of up to 2 and 3 months did not decrease significantly the thyroid hormone secretion rate (TSR), but PBI and thyroid size were increased slightly as compared to the corresponding control rats fed Purina Lab Chow. Fecal loss of ^{131}I was observed to be higher in the low iodine diet group of rats as compared to those consuming Purina Lab Chow food. On the low iodine diet, the percentage uptake of thyroidal- ^{131}I was greatly increased and the biological half-life of thyroidal- ^{131}I was significantly reduced, indicating a faster turnover of thyroidal-iodine (hormones). It was concluded that under these experimental conditions the rat thyroid has the capacity to increase its activity to compensate for any moderate low dietary iodine at least for 2 to 3 months.

diets *some* *have been reported*
 X Low iodine ~~diets~~ ^{some} in experimental animals and humans are known to result in goiter when iodine deficiencies occur. As iodine intake approaches a critical balance between intake and elimination to satisfy the animal's demands, the efficiency of iodine utilization increases markedly. Since iodine is the essential raw material for synthesis of thyroid hormones, chronic iodine deficiency would decrease and ultimately cause reduction in hormone synthesis leading to iodine deficiency symptoms such as goiter production.

Levine et al. (1933), Remington and Levine (1936) and Remington (1937a, 1937b) produced a diet from grains grown in iodine deficient soil. It contained 0.015-0.08 ppm of iodine. This level of iodine in the diet has been found to be variably effective in producing goiter as indicated by reports from Greenwald (1946), Money et al. (1952), Maloof et al. (1952), Axelrod et al. (1955), Van Middlesworth (1955), Taylor and Poulson (1956), Studer and Greer (1965), Dimitriadou et al. (1966) and Reineke and Lorscheider (1967). Although the experimental conditions *differed only slightly* ~~were different~~ and the iodine content of the diet varied *very little* ~~in~~ these experiments, the results were ~~varied in that~~ *varied in that* goiter in the rat was produced in two weeks in some reports while in other cases thyroid enlargement did not occur for many weeks.

The object of this study was to determine the functional activity of the thyroid in the albino rat at intervals for 2 to 3 months after feeding a low iodine diet. While low iodine diets have been studied for goiter formation and iodine metabolism, little study has been made on the thyroid hormone secretion rate (TSR) in the rat after iodine restriction. In addition, TSR and other parameters of thyroid activity such as PBI, thyroidal uptake

and release rates, and fecal and urinary losses were also studied to supplement the TSR observations.

Materials and Methods

Two different low iodine diets were used. One diet fortified with vitamins (powdered) was obtained from the Nutritional Biochemical Corporation, Cleveland, Ohio (NBC-LID) and the same shipment of the diet was used in the experiments. The low iodine test diet ⁺ fortified with vitamins (NBC, Cleveland) contained oil (vegetable-hydrogenated), 14%; salt mixture H.M.W. (free of KI), 3%; starch corn, 56%; and vitamin test casein, 27% plus vitamin diet fortification mixture (Diets Manual, NBC, Cleveland, 1967). ^{the diet was found to contain 5.83 kcal/gm.} The other low iodine diet was prepared in the Agricultural Chemistry Department, University of Missouri, Columbia (Ag. Chem.-LID). This low iodine diet (Ag. Chem. Univ. of Mo.) contained corn starch, 61%; vitamin free casein, 18%; Brewer's yeast⁺, 10%; B₁₂ (3 g cyanocobalamine, Merck, per kg of corn starch), 1%; salt mixture #6112, 5%; cottonseed oil, 4%; Vit. D, E and K in cottonseed oil, 1%; and ^{note} Carotene, 0.001%. The energy value of this diet was 4.36 kcal per gram. The iodine contents of these diets were analyzed by Wisconsin Alumni Research Foundation, Madison, and were reported to contain 0.06 and 0.05 ppm, respectively. These two diets were used in two different sets of experiments.

The control diet used in this study was Purina Lab Chow. It was reported to have an energy value of 4.25 kcal per gram, a protein content of 23.4% and an iodine content of 1.7 ppm.

Young female rats of the Sprague-Dawley-Rolfsmeyer strain were used in all the experiments. They were housed in wire cages in

groups of 5 and the cages were frequently cleaned of fecal material to avoid coprophagy. The rats were housed in a large animal room at 25.5°C with 14 hours of artificial light *daily*.

Expt. 1. NBC-LID

TSR: The individual TSR of a group of 30-day old rats was estimated by the method of Pipes et al. (1958). A goitrogen, methimazole-tapazole, was also injected s/c at the level of 0.4 mg/100 g bw/day during the entire period of TSR estimation to block the recycling of metabolized ^{131}I . The rats were then divided into two groups on equal TSR basis. One group of rats received the NBC-LID ad libitum and distilled water and the other group received Purina Lab Chow and tap water. The NBC-LID ~~diet~~ was fed to the experimental rats for a total period of two months and TSR was estimated at intervals of one month. Rats on low iodine diets were injected i/p with 3 μCi ^{131}I and the TSR was determined.

Half-life of thyroidal- ^{131}I : Two separate groups of rats on equal TSR basis were used to determine the $t_{1/2}$ of thyroidal- ^{131}I at one month intervals. The low iodine diet group was injected i/p with 3 μCi ^{131}I and the first thyroidal γ count was taken after 48 hours. At this time 0.4 mg/100 g bw tapazole was injected s/c to each rat and thereafter once each day until 5 thyroidal- ^{131}I counts were obtained at 2-day intervals. Rats on Purina Lab Chow were injected with 10 μCi ^{131}I .

Percent uptake of thyroidal- ^{131}I : The rate of thyroidal- ^{131}I uptake was measured after the rats had been fed NBC-LID for 2 months. After i/p injection of 3 μCi ^{131}I , the first thyroid count $\dagger$ was made after 1 hour and thereafter at ~~2, 3, 4, 5, 6, 7, 8, 12,~~ 24, 36 and 48 hours ^{after injection.} Thyroidal- ^{131}I counts were made with a

Nuclear Chicago Model DS-5 scintillation probe containing a 2" X 2" sodium iodide crystal attached to a Picker ~~Array Corporation~~ Rate-meter, Model 5866. For the thyroidal-¹³¹I count in the rat, the animal was slightly anesthetized with ether and the neck-thyroid region was pressed slightly against the surface of the scintillation probe for a period of 20 to 30 seconds until the pointer was at rest. The highest thyroidal-¹³¹I count obtainable at the time of counting was recorded.

Excretion of ¹³¹I in urine and feces: After determining the second TSR at 2 months of NBC-LID feeding, ^{at least 4} ~~1-5~~ days were allowed for the decay of the remaining radioactivity in the rats. Groups of rats were selected at random from experimental and control groups and transferred to metabolic cages. After 3 days of adjustment period, 10 ^μci ¹³¹I was injected i/p to each rat in the group. The first urine and feces samples were collected after 24 hours of ¹³¹I administration and thereafter each day for a total period of 5 days. Urine and feces of each rat were stored separately at -20°C with a drop of formalin. The fecal material was dried in an oven and the total weight was recorded. The ¹³¹I radioactivity of a known quantity of fecal material and aliquot of urine were measured in a gamma well counter and the percent of the injected dose was calculated for each day's total feces and urine. For counting, a well counter (Picker Model, No. 2804E) having a thallium-activated sodium iodide crystal measuring 1 3/4" X 2" with a well transmission of greater than 90 percent surrounded by 2" of lead was used.

Experiment 2. Aqu. Chem.-LID

The determination of TSR and $t_{1/2}$ of thyroidal- ^{131}I in rats was repeated, but in this experiment the rats were fed the low iodine diet for 3 months. Since tap water in this locality contained little iodine (~~2-50 $\mu\text{g/l}$~~ ^{200 $\mu\text{g/l}$}) the rats in both the groups were given tap water. The TSR and $t_{1/2}$ times were determined in separate groups of rats at monthly intervals as described previously. The PBI, feed consumption, wet thyroid, adrenal and pituitary weights and DNA of the thyroid and adrenal glands were also determined to include other criteria of the functional state of the thyroid.

Feed consumption: For measuring the feed consumption, 12 rats each from the group of rats used for TSR determination were selected at random and transferred to metabolism cages designed to prevent feed loss and coprophagy. After an adjustment period of ³~~and~~ few days, a measured quantity (20 g) of feed was put in the feeding cup daily and the balance remaining the next morning was subtracted to obtain the amount of feed consumed. An average of 8 days^{or} feed consumption was considered the daily feed intake.

PBI: At the end of the three month experimental period, blood samples were collected by heart puncture and serum obtained for PBI determinations by the method of Moran (1952). This was based on dry ashing and consisted of use of anionic exchange resins and ~~and~~ elution of the iodine with the arsenious reagent. The arsenious ion developed a color reaction with ceric ion and the optical density was measured in a DU-Spectrophotometer at 420 m μ . The reagents and glassware were obtained from Hycel, Inc. (Houston, Texas).

Wet ^gGland weights and DNA: The rats were killed in excess ether and the thyroid, adrenal and pituitary glands were collected on ice, cleaned and weighed on a torsion balance, accurate to 0.2 mg. The thyroid and adrenal glands were stored at -20°C in closed glass vials for later estimation of DNA. To obtain dry fat free tissue (DFFT) the thyroids and adrenals of six rats were pooled and extracted in 95% hot ethyl alcohol for 8 hours, then reextracted with fresh alcohol for another 8 hours, and finally with ether for 8 hours. The DFFT thus obtained was weighed and finely ground in a Wiley Mill. A known quantity of the powdered DFFT was then assayed for DNA (Webb and Levy, 1955). The total DNA gave an estimate of the cell population and the DNA per mg of DFFT gave an estimate of the cell size.

Results

Experiment 1. ^{NBC-LID.} The effects of feeding the NBC-LID to rats for two months on thyroidal- ^{131}I uptake, TSR and biological half-life of thyroidal- ^{131}I are shown in Table 1. It was observed that the low iodine diet did not decrease the TSR ^{during} up to a period of two months as compared to the control. A decline in the TSR of the Purina Lab Chow fed rats was observed due to advancing age (Narang and Turner, 1966; Kumaresan and Turner, 1967), but there was no significant difference between the TSR of the group on low and high iodine diets. The 48-hour thyroidal- ^{131}I uptake in the experimental group after the low iodine diet was fed for one month was 50% of the injected dose and increased to 84% after two months ^{on} ~~of~~ low iodine. The percent uptakes of the injected doses of ^{131}I at various times after injection are presented in Figure 1. The high-uptake

The high uptake by the thyroid suggested a gradual depletion in thyroidal and extra-thyroidal iodine pool and that the "iodine trap" was greatly stimulated. The significant decrease in biological $t_{1/2}$ of thyroidal- ^{131}I in the low iodine diet fed group indicated a faster turnover of thyroidal iodine. Since the TSR measured the net daily secretion of thyroid hormones, the results suggested that the rats fed low iodine diet were able to maintain an euthyroid condition by increasing "iodide trap" mechanisms and by a faster turnover of thyroid hormones.

A surprising observation of the experiment concerning excretion studies was that even on a low iodine diet, the total percent of injected dose of ^{131}I radioactivity in the fecal material was about 5 times more than that in the Purina Lab Chow group. Based on the total ^{131}I excretion for a 5-day period, fecal radioactivity accounted for 22% and urine accounted for 78% in the NBC-LID group as compared to 4% and 96% respectively in the high iodine group (Table 2). Since fecal iodine is considered to be mostly unmetabolized thyroxine, a large fecal excretion ^{was} difficult to ^{explain} reconcile ^{because} ~~when~~ the animal's iodine intake was reduced. It would seem that biliary secretion of the thyroxine-metabolite is not reabsorbed completely in the gut and so a part is excreted in the feces. The other possibility may be that NBC-LID contained something which increased the fecal thyroxine-metabolite. The mean daily feed intake was somewhat lower than the Purina Lab Chow, but since the energy value of the NBC-LID is higher the difference in feed consumption can be satisfactorily explained. The low dry matter content of the fecal material of rats fed the NBC-LID may be due to the fact that the diet contained lesser crude fibre content (lower residue) and therefore had a higher percent digestibility than the Purina Lab Chow.

The overall results of this experiment ^{showed} suggested that there was no significant decrease in daily total thyroid hormone release by the gland which prevented thyroid enlargement in the rat and that the rat's thyroid compensated ^{for} any deficiency of dietary iodine intake by increased recycling mechanisms and faster turnover of hormones, thus maintaining a normal level of thyroid hormones in the blood stream.

Ag. Chem.-LID

TSR: Results of feeding this diet to rats for 3 months are shown in Table 1. Feed intake measurements in the low iodine diet fed group provided a basis for roughly calculating the daily iodine intake. Since rats obtained very little iodine from tap water the total daily iodine intake from feed (12 to 15 g per day) was 0.60 - 0.75 ug based on the iodine content of the diet (≤ 0.05 ppm). The TSR's in the low iodine group after two and three months of feeding this diet were higher than that of the corresponding controls.

Since the secretion of TSH from the anterior pituitary was stimulated due to low iodine intake, ^{the} the TSR values obtained by the technique used may be slightly overestimated due to the fact that this technique is based on suppression of TSH and thereby thyroidal release of iodine ^{hormones}.

The percent ^{uptake} thyroidal-¹³¹I uptake at 48 hours after ¹³¹I administration did not increase above 52% in the low iodine group as compared to 85% in the previous experiment when the NBC-LID was fed to the rats. It may be pointed out that the NBC-LID group received distilled water whereas the Ag. Chem-LID group received tap water for drinking. Since the chloride content

of the diet and water^{ex} regulates the renal iodine clearance (Remington, 1937a; Axelrod and Leblond, 1952) it is possible that, in the Ag. Chem-LID group receiving tap water, iodide clearance by the kidney ^{just above} was higher and thus there was a relative decrease in plasma iodide concentration which led to lower uptake values. It was calculated that the NBC-LID and Ag. Chem.-LID contained 0.5% and 0.6% chloride, respectively. It is not clear that distilled and ordinary tap water may have produced this difference in renal clearance of iodide.

~~The lower thyroid uptake values in the Ag. Chem.-LID may be due to other factors including relative iodine content of the rat thyroids.~~

The mean wet thyroid, adrenal and pituitary weights are shown in Table IV. Although thyroids of rats on Ag. Chem.-LID were significantly larger than their corresponding controls, they cannot be called goitrous. Actually on visual examination they were hyperemic and looked hyperactive. Unfortunately, histological examinations of these thyroids were not made, but the total DNA/thyroid and DNA/mg DFFT indicated hyperplasia. Since DNA/mg DFFT is an index of cell size assuming constant DNA per epithelial cell, the data indicated that thyroids were more hyperplastic^e than hypertrophied (Table V).

The observation that adrenals of rats fed low iodine diet had significantly higher DNA/mg DFFT suggested stress to the animals, but the finding cannot be explained at this stage and requires further investigation.

The mean PBI¹⁵ in the two groups of rats were determined to be 5.3 and 4.6 ug%, which were not significantly different. It may be pointed out that the method used for PBI determination may not be sensitive enough or the PBI levels in these two groups of rats

were actual values within limits of experimental error.

Discussion

X The level of marginal and sub-marginal iodine intake in experimental animals has not been settled although it is recognized by various workers that rat thyroids have the capacity to increase markedly their functional state to compensate for a reduced iodine intake and maintain a euthyroid state for a considerable period of time. Halmi (1954) has studied regulation of the rat thyroid in short term iodine deficiency and reported that reduced dietary iodine intake for 19 to 20 days markedly expanded the capacity of the thyroidal iodide trapping mechanisms. Maloof et al. (1952) reported an increase in the thyroid weight and percentage uptake 11 days after feeding a low iodine diet. Van Middlesworth (1955) reported that the low iodine diet available commercially in 1953-55 (Nutritional Biochemical Corporation, Cleveland) contained 0.08 ppm in the diet and produced goiter in rats very slowly while another diet, no longer available, contained ^{1mg} 0.015 ppm iodine ^{and} produced goiter in 6 weeks. He observed thyroid enlargement by feeding a low iodine diet containing 0.08 ppm for 4 months or longer in the rat. More recently, Van Middlesworth (1969) fed a low iodine diet (0.02 ppm) for 10 months to rats and found the thyroids had enlarged to 5-8 times the normal size. Studer and Greer (1965) fed a low iodine diet containing 0.03 ppm iodine and obtained thyroid enlargement in Sprague-Dawley-Rolfsmeyer strain male adult rats by the seventh day ($P < 0.001$) and it continued to increase linearly.

X The data in the present study indicated that feeding a low iodine diet (with casein) containing less than 0.05 to 0.06 ppm iodine for 3 months to Sprague-Dawley-Rolfsmeyer strain young female rats did not produce goiter and did not decrease the thyroid

hormone secretion rate on ² daily basis, and thus ^{the rats} were able to maintain near normal levels of thyroid hormones in the blood stream. Since the young rats have been reported to require larger amounts of thyroid hormones for growth and reproduction than the adults per unit weight basis, it was interesting to find that 0.05 - 0.06 ppm iodine in the diet was not low enough to depress the net daily hormone secretion in young female rats for up to 3 months.

Low iodine diets have been reported to cause increased synthesis of L-triiodothyronine (L-T₃) in the thyroid of rats. Chromatograms of thyroid hydrolysates show increased MIT/DIT and L-T₃/L-T₄ ratios (Querido et al. 1957; Bois and Larsson, 1958; Studer and Greer, 1965; Heninger and Albright, 1966; ^{Yuei et al., 1968}). Increased L-T₃ content of the thyroid gland suggests increased synthesis and ^{is} assumed to reflect ^{increased} ~~be released~~ into circulation in higher proportion. Previous studies have indicated that in rats, L-T₃ is over twice as active biologically as L-T₄ on an equimolar basis (Pipes and Dale, 1963; Bauman et al., 1965). Increased synthesis and release of L-T₃ by ^{the} thyroid in ^{the} case of low dietary iodine intake would indicate an endogenous compensatory mechanism to meet the metabolic demands at the tissue level. This has been demonstrated recently by Greer et al. (1968).

X Studies have indicated that on low iodine diets the thyroidal and ~~body~~ pool of iodine is greatly reduced. There is high uptake of radioiodine, but ^{it} is equally rapidly discharged by the thyroid. The tremendous increase in turnover rate of the thyroidal iodine (hormones) ~~compensates or~~ ^{total} approaches ~~near~~ compensation in moderate dietary iodine deficiency. Based on the present study under the

existing experimental conditions, the authors believe that unless there is chronic deficiency of dietary iodine coupled with other alterations in body adaptations such as secretion and nature of thyrotropin, presence of goitrogens in the feed, reabsorption of thyroid hormones in the gut and utilization at the cellular level, the thyroid of the young adult female rat has tremendous capacity to increase its activity to alleviate any moderate degree of iodine deficiency for up to three months.

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Table I. Effect of low dietary iodine intake on TSR in female rats

Group	Dietary condition	No. of rats	Age (days)	Body wt. (g)*	thyroidal- ¹³¹ I uptake (%)	TSR ug L-T ₄ /100 g bw	Group	No. of rats	Age (days)	thy of thyroidal- ¹³¹ I release (hrs)
I	Purina Lab Chow	15	30	93.5±3.9	10.6±0.9	1.57±0.09				
			60	199.3±3.6	11.3±0.8	1.48±0.06	III	8	60	67.8±4.6
			90	219.3±4.7	13.5±0.9	1.12±0.07			90	69.1±5.3
II	NBC-LID	18	30	94.6±3.6	10.5±0.7	1.60±0.08				
			60	201.1±5.0	50.4±1.4	1.47±0.04	IV	9	60	59.4±51.1
			90	225.0±5.6	84.5±3.5	1.17±0.07			90	45.4±2.9
	Probability Students 't' test									
	P <		30	NS	NS	NS				
			60	NS	NS	NS			60	NS
			90	NS	NS	NS			90	.001
I	Purina Lab Chow		30	79.0±1.9	7.9±0.6	1.53±0.06				
			60	178.3±4.7	8.5±0.7	1.18±0.07	III	8	60	84.7±5.7
			90	203.3±5.2	11.3±0.9	1.08±0.05			90	67.8±5.5
			120	248.3±6.7	8.3±0.6	0.90±0.05			120	57.9±5.9
II	Ag. Chem.-LID		30	75.7±1.8	8.8±0.6	1.51±0.07				
			60	159.8±5.6	51.3±2.6	1.17±0.07	IV	8	60	54.5±4.4
			90	224.5±5.0	43.0±1.9	1.32±0.05			90	40.5±2.5
			120	227.4±4.2	42.9±2.4	1.27±0.03			120	29.8±2.2
	Probability Students 't' test									
	P <		30	NS	NS	NS			30	
			60	.02	.001	NS			60	.001
			90	.01	.001	.01			90	.001
			120	.02	.001	.001			120	.001

*Mean±standard error

NBC-LID is low iodine test diet fortified with vitamins, Nutritional Biochemical Corporation, Cleveland.

Ag. Chem. LID is low iodine diet prepared in the Agr. Chemistry Department, University of Missouri, Columbia.

FIGURE 1, UPTAKE OF ^{131}I BY THE THYROID GLAND IN
 90 DAY OLD FEMALE RATS GIVEN EITHER AN ADEQUATE IODINE
 DIET (PURINA LID (H₂O)) OR A LOW IODINE DIET (NBC-LID)
 FOR 60 DAYS

Table 2. Effect of low iodine diet on excretion of ^{131}I in feces and urine

Group	Dietary Condition	No. of Rats	Mean Body Weight (g)	Mean Daily Feed Intake (g)	D.M.* in Feces Per Day (g)	Excretory Material	Mean Excretion of ¹³¹ I (per cent dose)					Total for Five Days	% of Total Excretion
							Days						
							1	2	3	4	5		
1	Purina chow	7	236.0	15.6	2.85	Feces	1.85	0.66	0.39	0.33	0.30	3.53	3.7
						Urine	81.40	4.00	2.16	1.67	1.31	90.54	96.3
2	Low iodine diet (Ag. Chem.)	9	238.0	12.2	0.44	Feces	62.7	3.53	2.70	2.58	2.36	11.80	21.7
						Urine	38.68	3.90	3.48	2.31	2.09	42.47	78.3

*Dry Matter

Table 3. Effect of a low iodine diet on feed consumption in rats

Age (days)	No. of rats	Purina Lab Chow			Ag. Chem. LID		
		Mean body weight (g)	Feed Intake		Mean body weight (g)	Feed Intake	
			g/day	g/100 g bw ¹		g/day	g/100 g bw
100	12	238.5	16.5	6.9 $\pm$ 0.2	207.1	12.4	5.9 $\pm$ 0.2
100	12	258.7	18.7	7.2 $\pm$ 0.2	238.7	15.3	6.4 $\pm$ 0.3

* Mean $\pm$ standard error.

Table 4. Effect of a low iodine diet for three months on the thyroid, adrenal and pituitary wet weight and PBI

Group	Dietary Condition	No. of rats	Body Weight (g)*	Thyroid		Adrenal		Pituitary		PBI ug %
				Total (mg)	/100 g bw (mg)	Total (mg)	/100 g bw (mg)	Total (mg)	/100 g bw (mg)	
I	Purina chow	21	266.8 $\pm$ 8.8	16.8 $\pm$ 0.8	6.3 $\pm$ 0.3	59.9 $\pm$ 1.9	22.6 $\pm$ 0.8	11.0 $\pm$ 0.5	4.1 $\pm$ 0.2	5.3 $\pm$ 0.5
II	Low iodine diet (Ag. Chem)	21	233.7 $\pm$ 4.2	19.6 $\pm$ 0.8	8.4 $\pm$ 0.2	59.3 $\pm$ 1.5	25.5 $\pm$ 0.7	11.7 $\pm$ 0.2	5.0 $\pm$ 0.4	4.6 $\pm$ 0.5
Probability Student's 't' test P			.001	.02	.001	----	.02	----	.001	----

* Mean $\pm$ Standard Error

5
TABLE XVI

EFFECT OF A LOW IODINE DIET ON DNA CONTENT OF THYROID AND ADRENAL

Group	Condition	No. of Rats	Mean* Body Wt. (g)	Wet Wt. (mg)	Thyroid			Adrenal			
					DFFT (mg)	DNA/mg DFFT (μg)	Total DNA (μg)	Wet Wt. (mg)	DFFT (mg)	DNA/mg DFFT (μg)	Total DNA (μg)
1	Purina chow	21	266.8 +8.8	16.8 +0.8	2.58 +0.21	28.39 +2.82	71.78 +3.35	59.9 +1.9	6.84 +0.26	30.48 +1.83	207.45 +4.64
2	Low iodine diet (10.0 ppm)	21	233.7 +4.2	19.6 +0.8	3.01 +0.15	20.19 +0.91	60.33 +0.76	59.3 +1.5	7.46 +0.42	22.37 +2.66	167.19 +22.75
Probability Student's 't' test P<			.001	.02	----	.05	.01	----	----	.05	----

*Mean ± Standard error

ND I think there occurred an error in typing the DNA data. The correct seems to be like this.