ANALYSES OF YELLOW FIN TUNA
FISH TISSUES FOR RADIOACTIVITY

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The following report gives analyses of the tissues of a yellow fin tuna fish obtained from a Japanese import by Los Angeles District in May 1954. This fish was one of two shown to be slightly radioactive when surveyed with a portable Beta-Gamma meter. It was received at the laboratory in a frozen state and had been previously degutted and degilled. Samples for analysis of radioactivity were taken (1) from the raw fish, (2) after precooking, (3) after canning.

Procedure: Processing of the fish was carried out in the laboratories of the National Canners Association in collaboration with Dr. James Reed.

1. Tuna was brought to NCA laboratories on Monday, July 26, in a frozen state and permitted to thaw overnight at room temperature.

2. On Tuesday, July 27, the tuna, approximately 50 inches long was cut into head and tail sections respectively 29 and 21 inches. This procedure, comparable to standard canning practice, was necessary to accommodate the fish to the cooking basket. At this time portions of the edible and inedible tissues were taken for analyses.

3. The sections of fish were placed in two galvanized wire baskets 30" long and 16" wide and precooked in steam at 220°F to 225°F for 5 hours to a temperature of 145 to 160°F recorded on a thermometer inserted to the level of the vertebral column.

4. During cooking, a mixture of steam condensate and juices from the fish was collected. The total liquid amounting to 6725 ml. was concentrated and yielded approximately 714 gms. solids. An aliquot was taken for analysis.

5. The precooked sections were cooled at room temperature overnight. On Wednesday, July 28, they were cleaned, the edible sections separated and prepared for canning. At this time edible and inedible portions of the precooked fish were taken for analysis.

6. Canning was done as follows:

   Can Size: #2 fleet (307 x 204)

   Fill-in Wt.: 7 to 7⅓ oz.

   Fill-in Salt: ¼ oz.

   Fill-in Cotton Seed Oil: 1.52 fl. oz.

   Cans were sealed under 25" gauge vacuum and processed at 240°F in steam for 85 minutes, followed by water cooling.

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7. Coding. Looking from the tail of the tuna toward the head, the four loins were coded as follows:

A = Upper left loin

B = Upper right loin

C = Lower right loin

D = Lower left loin

A minimum of 10 cans were filled from each loin with the cans being numbered 1 to 10 to represent progression from head to tail. Cans #10 and #9 were from the tail section and cans #8 to #1 were from the head and body section.

Code	Total	Cans Numbered
A	13	1,2,2,3,3,4,5,6,7,8,9,10,10
B	12	1,2,3,3,4,4,5,6,7,8,9,10
C	10	1,2,3,4,5,6,7,8,9,10
D	11	1,2,3,3,4,5,6,7,8,9,10

Total 46 cans

For analysis of the canned meat, samples were taken from the coded cans in such a way that meat from (1) near the head, (2) at mid section and (3) near the tail was represented.

For control 1951 and 1954 pack was used with samples representative of Pacific Yellow fin and Atlantic Coast "little" tuna.

Radiological Analyses.

Wet weight samples ranging from approximately 3 to 40 grams were placed in 100 ml. pyrex beakers and ashed at 500°C for 24 hours. Ash weights were recorded and the ash broken up into a fine powder and distributed as evenly as possible over 10 ml. capacity aluminum "milk top" planchettes, having a diameter of 5 centimeters. Samples were read for 10 minutes. Values were corrected for background and expressed as disintegrations per minute. Standard Basis: U.S. Bureau of Standards. Beta Ray Standard. RaD/E #1162 corrected to August 1, 1954, = 127.8 d/sec.

In three experiments, counts per minute were read against increments of ash weight. Within the range of ash weights recorded, this relationship was shown to be linear. No corrections for self-absorption were consequently made.

Results.

Since no corrections have been made for radioactive potassium normally present in fish tissues, orientation regarding the significance of the radioactivity recorded must be obtained by reference to the control values. In Table 5 are assembled some of the readings on the edible white meat of the radioactive tuna in comparison with controls. While the amount of data is probably too small for statistical evaluation, there is indication that the raw flesh does contain a small excess of radioactivity over that of the controls, but this is lost in the process of cooking and canning. If this is so, then the marked activity of the exudate (Table 3) may be a partial explanation. It is believed that the exudate represents a "cooking out" of minerals some of which (potassium included) may be radioactive. Support for this argument may also be noted in that loss of activity by cooking is only 20% when expressed on the basis of the wet weight but 40% when expressed on the basis of the ash weight.

Generally, it can be stated that the processed flesh of the "radioactive" tuna does not contain significant amounts of activity over that of control tuna. Referring to Table 3 showing analyses of canned samples from different locations on the fish, it is evident that distribution of radioactivity does not follow any significant trend, and is uniform.

In order to assess the significance of the radioactivity measured in other tissues of the fish, comparable control tissues would, of course, also have to be analyzed. Reference to Tables I and II shows nevertheless that some of the other tissues, notably skin, gill, etc., did have significantly higher values than the edible flesh. Contrary to expectations, however, no significantly high "standout" values for bone are recorded.

Conclusions:

(1) There is a small but significant elevation of radioactivity in the raw import sample of yellow fin tuna.

(2) Processing of the edible flesh reduced the radioactivity to the same level as that of the controls.

(3) Considering the low levels of radioactivity involved, there is no question of injury to health from ingesting the canned meat.

Table I

RAW FISH**

Sample Taken	Location of Sample on Fish	Weight of Sample in Grams		Radioactivity of Sample in Disintegrations per Min(D/m)		
		Wet	Ash	Total	per gram wet wt.	per gram ash wt.
White Meat	Upper left loin 21" from tail (A-9)	35.61	0.7097	107	3.0	146
White Meat	Upper left loin 20" from snout, flank side (A-5)	43.28	1.0104	122	2.8	121
White Meat	Lower left loin 20" from snout, flank side (D-5)	34.48	0.7768	120	3.5	155
Dark Meat*	Upper left loin 29" from snout	16.76	0.2165	66.3	4.0	306
Meat*	Ventral area of body cavity	25.61	0.3460	74.2	2.9	215
Vertebrae	Tail portion	14.67	3.6523	63.7	4.3	17
Piece of gill	Small remainder from right gill cavity	3.42	0.3119	33.0	9.7	106
Skin	Below left gill flap	16.00	1.9160	63.2	4.0	33
Gullet	From base of mouth and gullet with bone attached	16.42	1.3788	83.9	5.1	61

*Not ordinarily canned
**Analyses made August 4

Table II

PRECOOKED FISH**

Sample Taken	Location of Sample on Fish	Weight of Sample in Grams		Radioactivity of Sample in Disintegrations per Minute (D/m)		
		Wet	Ash	Total	per gram wet wt.	per gram ash wt.
White Meat	Lower left loin 21" from snout flank side (D-5)	32.00	1.0610	69	2.1	65
White Meat	Upper left loin 21" from snout flank side (A-5)	24.43	0.8026	65	2.7	81
White Meat	Lower right loin 21" from snout (C-5)	32.43	0.8670	91	2.8	106
Dark Meat*	Tail portion	17.07	0.3037	54	2.1	178
Meat*	Next to gill cavity	24.41	0.3595	110	4.5	307
Vertebrae	Mid-section, head end	18.00	2.0662	48.5	2.7	23
Skin	Tail portion	11.38	2.1879	63	5.6	29
Skin	Under gill flaps	15.42	3.9463	84	5.5	21
Dark Meat*	Head	18.36	0.2615	108	5.9	410
Bone	Head	25.52	7.8720	110	4.3	14
Cooking exudate		714	92	18,600	26	2000

*Not ordinarily canned
**Analyses made August 4

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Table III

CANNED FISH*

Location of White Meat (loins) According to Code	Weight of Sample in Grams		Radioactivity of Sample in Disintegration per Minute (D/m)		
	Wet	Ash	Total	per gram wet wt.	per gram ash wt.
Near head					
A1	15	0.5263	35	2.3	67
C1	15	0.6353	36	2.4	57
B3	15	0.4743	36	2.4	76
D3	15	0.4367	20	1.3	46
Near middle					
A5	15	0.4883	36	2.4	74
B5	15	0.4956	29	1.9	54
C5	15	0.4837	28	1.9	53
D5	15	0.5932	33	2.2	56
Near tail					
B10	15	0.5295	26	1.7	49
D10	15	0.5560	32	2.1	58
A9	15	0.5572	19	1.3	34
C9	15	0.6385	40	2.7	63

* Analyses made August 20

Table IV

CANNED FISH, CONTROL

Source	Code	Weight of Sample in Grams		Radioactivity of Sample in Disintegration per Minute (D/m)		
		Wet	Ash	Total	per gram wet wt.	per gram ash wt.
Atlantic Coast "little" tuna 1951 pack	9	42.40	1.1227	69	1.6	61
	10	30.20	0.7773	55	1.8	71
Pacific Coast 1954 pack	P_1Y_3	15	0.3970	33	2.2	82
	P_1Y_2	15	0.4609	39	2.6	85
	P_1Y_1	15	0.4997	36	2.4	72

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Table V

Radioactivity in White Meat

Disintegration per Minute

	Raw		Precooked		Canned		Canned Control	
	per gram wet wt.	per gram ash wt.	per gram wet wt.	per gram ash wt.	per gram wet wt.	per gram ash wt.	per gram wet wt.	per gram ash wt.
	3.0	146	2.7	81	2.1*	62*	1.6	61
	2.8	121	2.1	65	2.0*	51*	1.8	71
	3.5	155	2.8	106	2.1*	59*	2.2	82
							2.6	85
							2.4	72
Av.	3.1	141	2.5	84	2.0	57	2.1	74

* Average of 4 values.

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TABLE I

Tissue Sample	MFP I	MFP II	MFP III	Sr - Ba I	Sr - Ba II	Ba I	Ce I	Sr^{89-90} III	Sr^{90} III
Muscle									
Tail	5.2	5.5							
Anterior	8.6			7.9		1.1	2.6		
Midbody	21.2			0.7		0.9	0.9		
Dorsal		0.1							
R. Lateral									
L. Lateral			3.8					0.06	0.04 ± 0.0149
Skin	125			11.5		9.2	1.9		
Dorsal		26.6							
Ventral		0							
L. Lateral			12					0.04	0.07 ± 0.015
R. Lateral			7					0.34	0.27 ± 0.063
Intestines									
Liver	70								
Intestines	149								
Intestines	480			37		20	10		
Gut		4.5							
Viscera			120					0.1	0.005 ± .0013
Kidney		30							
L. Gill	54								
R. Gill	80								
R + L Pectoral Fin	66								
Bone									
Vertebra									
mid	73			9.1		5.4	1.1		
fore				7.2		5.8	3.8		
H. V. Tail	27	0			0.16 ±0.12				
Backbone		32	25					0.4	0.07 ± 0.025

Fish IV	d/m/sample
Liver	5,300
Spleen	30,400
Muscle	1,600 (8.8 d/m/gr)

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