407874

Reprinted from ENVIRONMENTAL Science & Technology

Vol. 5, July 1971, Pages 634-635
Copyright 1971 by the American Chemical Society and reprinted by permission of the copyright owner

Mercury in Selected Fish Protein Concentrates

Thomas M. Beasley[1]

Laboratory of Radiation Ecology, College of Fisheries, University of Washington, Seattle, Wash. 98105

■ Levels of mercury in fish protein concentrates (FPC) have been measured. Concentrates prepared from surface feeding fishes taken from different locales contained 0.3 to 0.9 ppm mercury. These concentrations appear consistent with the known enrichment factors which occur in the chain: water–fish–concentrate.

Fish protein concentrates (FPC) are currently under study as a possible source of protein for the diet of the world's populations. These products are made by processing whole marine organisms which yield a palatable supplement having a protein content of about 80% (Ayres, 1966). Previous measurements of radionuclides in FPC have shown that the enrichment of radioactivity through the chain: water–organism–concentrate was significant (Beasle yet al., 1969). Such enrichment processes must also occur in the case of trace elements. Thus, if not removed in processing, undesirable amounts of certain trace elements might be present in final FPC products. In particular, mercury concentrations in these products are of interest, since both natural and industrial input of this element to the environment is currently a topic of national concern (Abelson, 1970). Therefore, the analysis of a limited number of FPC products was undertaken to determine whether or not, in the case of mercury, the enrichment processes discussed above were significant.

The FPC products were obtained from the National Center for Fish Protein Concentrate, College Park, Md. Mercury was determined in the concentrates by dissolving 10-g samples with concentrated HNO_3 and $HClO_4$ acids in a Bethge apparatus as suggested by Gorsuch (1959). High specific activity ^{203}Hg (>0.1 Ci/g) was used to determine mercury recovery through dissolution, solvent extraction (Handley and Dean, 1960), and final colorimetric determination using the dithizonate complex of mercury (AOAC, 1965). Several concentrates were analyzed twice; once as received and a second time after addition of a known amount of mercury. This was done to confirm the validity of yield determinations using ^{203}Hg. In all cases, total mercury concentrations agreed well with the sum of the mercury in the concentrate and the mercury which was added. Duplicate analyses were performed for each concentrate.

The results in Table I indicate significant concentrations of mercury in these products. The value for alewife taken from Lake Michigan may reflect the input of unusual amounts of mercury to these waters from industrial sources (Abelson, 1970). The concentrates prepared from fishes taken from the open oceans are surprisingly similar in their Hg concentrations. It is interesting to note, however, that Robertson (1970) recently reported fairly uniform concentrations of mercury (~0.1 μg Hg/liter) in surface water samples taken from the Atlantic and Pacific oceans and Mediterranean sea. Assuming this uniform concentration of mercury in surface waters and an accumulation factor of 10^3 for Hg in fishes (Johnels and Westermark, 1969), wet weight concentrations of mercury in surface feeding fishes should approximate 0.1 ppm Hg. Since a further concentration factor of approximately 5 occurs in the preparation of fish protein concentrates (Brown, 1970), Hg concentrations near 0.5 ppm in these products might be expected. Considering the approximate, rather than the exact, nature of the parameters used in this calculation, the agreement between the observed concentrations of Table I and those expected is quite good. This suggests that mercury is not removed in the process used to produce these products.

The mercury concentrations measured here exceed the "practical residue limit" for marine products of 0.02 to 0.05 ppm established by committees of the Food and Agricultural Organization of the United National (WHO, 1967) and several exceed the "action level" of 0.5 ppm recommended by the U.S. Food and Drug Administration. However, Berglund and

[1] Present address: Environmental Sciences Branch, Division of Biology and Medicine, Atomic Energy Commission, Washington, D.C. 20545.

DOE ARCHIVES

Table I. Average Mercury Concentrations in Selected Fish Protein Concentrates

Sample	Catch date	Location	Mercury concentration (μg Hg/g dry concentrate) ±5%
Alewife (*Alosa pseudoharengus*)	April '69	Lake Michigan	0.90
Anchovy (*Engraulis mordax*)	January '69	California coast	0.44
Atlantic herring (*Clupea harengus harengus*)	November '68	Massachusetts coast	0.60
Gulf menhaden (*Brevoortia patronus*)	May '69	Mississippi coast	0.51
Ocean pout (*Macrozoarces americanus*)	January '69	Massachusetts coast	0.42
Menhaden (*Brevoortia tyrannus*)	June '69	Chesapeake Bay	0.34[a]

[a] Average of three concentrates processed from catches taken at the same time.

Berlin (1969) have proposed a "temporary allowable daily mercury intake" of 60 μg which would take into account not only specific concentrations of mercury in foodstuffs but also an estimate of the quantity of such food ingested. Bowen (1966) lists the adult dietary intake of mercury as 5–20 μg/day. If we reasonably assumed a 10–30 g/day intake of FPC and a current dietary Hg intake of 20 μg/day, then none of the products shown here would contribute quantities of Hg to the diet which would exceed Berglund and Berlin's recommended total Hg intake.

It would seem prudent to continue trace element measurements on these and other food products which employ a technological concentration step in addition to those which occur naturally. Increasing concentrations of these entities in the environment may, at a future time, require process modifications for their removal.

Literature Cited

Abelson, P. H., *Science* **169,** 237 (1970).
Association of Official Agricultural Chemists, "Official Methods of Analysis of the AOAC," 10th ed., Washington D.C., 1965, p 957.
Ayres, J., *Science* **152,** 738 (1966).
Beasley, T. M., Osterberg, C. L., Jones, Y. M., *Nature* **221,** 1207 (1969).
Berglund, F., Berlin, M., "Chemical Fallout," M. W. Miller and G. G. Berg, Eds., Charles C. Thomas, Springfield, Ill., 1969, pp 423–32.
Bowen H. J. M., "Trace Elements in Biochemistry," Academic Press, London, 1966, pp 116 and 117.
Brown, N., National Center for Fish Protein Concentrate, private communication, 1970.
Gorsuch, T. T., *Analyst* (*London*) **84,** 135 (1959).
Handley, T. H., Dean, J. A., *Anal. Chem.* **32,** 1878 (1960).
Johnels, A. G., Westermark, T., "Chemical Fallout," M. W. Miller and G. G. Berg, Eds., Charles C. Thomas, Springfield, Ill., 1969, pp 221–241.
Robertson, D. E., Tech. Rept. BNWL-1307, Pacific Northwest Laboratory, 1970.
WHO Tech. Rept. Ser. 370, 1967.

Received for review November 19, 1970. Accepted February 5, 1971. Work supported by the Atomic Energy Commission through contract no. AT(45-1)-2225, Task Agreement 14.

DOE ARCHIVES

RESEARCHERS VISITING BIKINI ATOLL
1972 - 1978

DATES	RESEARCHER/TEAM LEADER*	PURPOSE
Oct./Nov., 1972	F. Lowman, PRNC V. Noshkin, LLL W. Schell, Univ. of Wash.	Marine studies
4/10-15/74	S. Cohn, BNL	Whole body counti
Oct./Nov., 1974	F. Lowman, PRNL	Marine studies
12/5-11/74	N. Greenhouse, BNL G. Haywood, M.D., Univ. of Wash. V. Nelson, Univ. of Wash.	Radiological studies
3/19-25/75	N. Greenhouse, BNL R. Conard, M.D., BNL	Radiological and Medical studies
6/18-25/75	W. Robison, LLL N. Greenhouse, BNL V. Nelson, Univ. of Wash. W. Bliss, EPA	Radiological studies
8/19-31/75	J. Randall, Univ. of Hawaii	Marine studies
9/22-26/75	R. Conard M.D., BNL	Medical studies
12/3-20/75	J. Randall, Univ. of Hawaii W. Schell, Univ. of Wash.	Marine studies
2/28-3/2/76	W. C. Weimer, PNL	Marine studies
3/26-28/76	N. Greenhouse, BNL R. Conard, M.D., BNL	Radiological and medical
7/3-13/76	J. Randall, Univ. of Hawaii	Marine studies
9/30-10/2/76	K. Knudsen, M.D., BNL V. Nelson, Univ. of Wash. N. Greenhouse, BNL W. Weimer, PNL	Medical studies and radiological studies
1/1-11/77	K. Knudsen, M.D., BNL	Medical
2/18-3/4/77	W. Robison, LLL R. Buddemeier, Univ. of Hawaii	Radiological (Food, Fish, and water) studies

DOE ARCHIVES

DATES	RESEARCHER/TEAM LEADER*	PURPOSE
3/30-4/4/77	R. Conard, M.D., BNL S. Cohn, BNL	Medical and whole body counting
4/25-5/10/77	W. Schell, Univ. of Wash.	Marine studies
5/12-13/77	N. Greenhouse, BNL	Radiological studies
6/25-29/77	K. Knudsen, M.D., BNL	Medical studies
8/8-31/77	W. Robison, LLL	Radiological (Food) studies
9/18-21/77	K. Knudsen, M.D., BNL	Medical studies
10/22-26/77	N. Greenhouse, BNL	Radiological studies
10/26-31/77	W. Schell, Univ. of Wash.	Marine studies
4/24-27/78	R. Conard, M.D., BNL	Medical studies
4/24-29/78	N. Greenhouse, BNL	Whole body counting

*BNL - Brookhaven National Laboratory
EPA - Environmental Protection Agency
LLL - Lawrence Livermore Laboratory
PNL - Pacific Northwest Laboratory
PRNC - Puerto Rico Nuclear Center now
Center for Energy and Environmental Research
Univ. of Hawaii - University of Hawaii
U. of W. - University of Washington

DOE ARCHIVES