POSSIBLE ATOMIC ENERGY COMMISSION ASSISTANCE OF RESEARCH ON RADIATION PRESERVATION OF FISH

The Ad Hoc Committee to the Interdepartmental Committee on the Radiation Preservation of Foods has recommended that Federal agencies, in line with the President's Atoms for Peace Program, sponsor further research into the preservation of foods through radiation. As a result of this recommendation, representatives of the U. S. Bureau of Commercial Fisheries were invited to discuss with Atomic Energy Commission (AEC) representatives the potential of fishery products as a food on which intensive research might profitably be conducted. The unique needs of the fresh fish trade for an improved method of preservation, such as radiation preservation, as well as the very encouraging findings of the Bureau in this field, were outlined.

On the basis of the discussion, the AEC is prepared to concentrate its efforts in radiation preservation research on the products of the fishing industry. There is in preparation a research program and justification for presentation to Congress. The Chief of AEC's Office of Isotopes Development has indicated that it may be possible to supply one of the Bureau's technological laboratories with a mobile reactor suitable for fisheries research. He also expressed some interest in the possible use of isotopes as a tracer to evaluate the extent of water pollution in the effluent of various industrial plants.

OPTIMUM LEVEL OF MENHADEN FISH MEAL AND SOLUBLES AS SOURCES OF GROWTH FACTORS IN BROILER DIETS

In broiler feeding experiment No. 13 conducted at the University of Delaware, rather conclusive evidence was obtained as to responses obtained from fish meal and condensed fish solubles in a corn-soy diet not supplemented with methionine. This experiment was part of a study conducted under a contract between the University of Delaware and the Bureau of Commercial Fisheries financed with funds derived from the Saltonstall-Kennedy Act (Public Law 466, 83rd Congress, 1954).

In this test, selected day-old White Rock cockerels were allotted randomly to 20 groups of 50 chicks each and were housed in floor pens at the poultry farm at the University of Delaware. The weight of each chick and the feed consumed by each group of chicks were determined at the end of eight weeks.

All diets fed to the various groups of chicks were prepared from a constant amount of basal mash consisting of ground yellow corn, soybean meal, corn gluten meal, alfalfa meal, vitamin premix, salt, and a trace mineral mix. This mash was the base of the experimental diets to which were added varying levels by weight, of menhaden fish meal or menhaden fish meal and condensed fish solubles. Each varying level of fishery product added, however, was done so in duplicate to permit formulation of paired diets containing the same levels of fish meal or fish meal and solubles, but containing different levels of total protein. The diets then were individually balanced with corn meal, soybean meal, fat and bone meal to formulate comparable diets, containing either 22 percent total protein or 26 percent total protein and 1,050 calories of productive energy per pound. No supplementary methionine was added to these diets. Actual chemical analyses were conducted on a random selection of three of the diets containing 22 percent protein and three of the diets containing 26 percent protein. Results indicated that the calculated analyses of the diets were accurate.

The moisture, protein, fat and ash contents were 7.0, 62.6, 12.6, and 16.0 percent, respectively, for the commercial sample of menhaden meal used in this test. The fish meal had been treated with the antioxidant butylated-hydroxy-toluene (BHT). The moisture, protein, fat and ash contents were 49.8, 33.8, 8.7, and 8.0 percent, respectively, for the commercial samples of condensed menhaden solubles used in this test. Values of 1,030 and 612 calories of productive energy per pound for the menhaden meal and solubles, respectively, were utilized in formulating the various diets containing the fishery products.

In each experimental series there was a control diet that contained no added fish meal or solubles and three diets that contained only fish meal--one each at a level of 2.5, 5.0, and 7.5 percent by weight. The six remaining diets in each series contained the fish meal and solubles in combination. Three of these diets contained a level of 2.5 percent fish solubles by weight--one each with 2.5, 5.0, and 7.5 percent fish meal. And three of these diets contained a level of 5.0 percent fish solubles by weight--one each with 2.5, 5.0, and 7.5 percent fish meal.

1. In the 22-percent protein diet, all levels of fish meal gave a significant improvement.

2. The condensed fish solubles gave a response which was additive over the fish meal.

3. The 26-percent protein basal ration gave much better growth than the 22-percent basal ration. However, the 22-percent ration with 5-percent fish meal and 4.8-percent fat gave equal growth and better feed conversion than the 26-percent basal with 8-percent fat. The responses from fish meal and condensed fish solubles were not as great on the 26-percent diet as the 22-percent diet insofar as growth was concerned, but they did show improvements in feed conversion.

We believe that these data present definite results of importance in the practical use of fish meal and condensed fish solubles. Fish meal has its greatest value in the lower protein ration. This is entirely logical because quality of protein or the best supply of essential amino acids becomes most important in the lower protein ration. As the level of protein is increased, the need for more fat to keep the diets iso-caloric is demonstrated; and, fat costs as much or more than fish meal depending upon geographic location.

To say the above in another manner, it is obvious that when all the essential amino acids are supplied at the lowest possible level of protein, it is possible to use more corn as an economical source of energy. In formulating feeds on this basis, synthetic methionine must be given consideration too. In fact, we believe that it makes an economic contribution where fish meal is used in the corn-soy basal diet.

It must be constantly kept in mind that the economic contribution fish meal makes must be judged on the basis of its over-all values as shown by comparison with the New England College Conference ration, where methionine is added, and a substitute formula without fish meal.

On the basis of costs at Lancaster, Penn., the 22-percent ration with 5-percent fish meal, and the 22-percent ration with 5-percent fish meal and $2\frac{1}{2}$-percent condensed fish solubles, cost less than the 26-percent ration without fish products which gave significantly poorer growth and feed conversion. This difference will, of course, vary in different sections of the country.

Our present research problem is to develop calorie to amino acid requirements and not be satisfied with calorie to protein requirements. Our leading investigators in poultry nutrition have emphasized this fact.

SUPPLEMENTARY EFFECT OF FISH MEAL AND FISH SOLUBLES IN CHICK DIETS

Rather extensive research with chicks fed commercially-practical broiler diets in batteries has failed to indicate at this time that commercial variables in processing will affect the uniform value of fish products.

When condensed menhaden fish solubles were superimposed upon menhaden fish meal in experimental treatments, their chick-growth promoting effect was additive.

Five percent fish meal and 2.5 percent condensed fish solubles in combination were found to be a practical level of fish products for the study of their chick-growth promoting properties.

A 26-percent protein unsupplemented corn-soy-fat chick diet produced superior growth to a 22-percent unsupplemented protein diet equated for energy. When these diets were supplemented with a combination of 5-percent fish meal and 2.5-percent fish solubles, the results from both diets were improved, but the lower protein diet was improved to a greater extent making the two different protein levels comparable. This is interpreted to be due to improved amino acid balance.

Preliminary findings indicate that results from battery experiments with fish products may not be applicable to floor pen studies under commercial conditions.

This information on the biological value of fish meal using practical chick-type rations was revealed by a study conducted under a contract awarded the University of Delaware by the U. S. Bureau of Fisheries and financed by funds derived from the Saltonstall-Kennedy Act (Public Law 466, 83rd Congress, 1954).

The findings included information on the following:

1. The effect of processing variables on the feeding value of fish meals.

2. The additive effect of fish meal and fish solubles on chick growth.

3. Practical feeding levels of fish meal and fish solubles.

4. The effect of amino acid balance upon dietary protein level.

5. The value of fish meal fed to chicks in floor pens versus battery brooders.

FISH MEAL AS A SOURCE OF UNKNOWN GROWTH FACTOR AND HIGH-QUALITY PROTEIN

During 1955 and 1956 more than 20 samples of commercial and experimental fish meals were assayed for unknown growth factors. A standard sample of fish solubles was fed at several levels in each assay. It was assigned a potency of 10. The comparative potencies of the fish meal samples ranged from 2.5 to 13.8. The values for 8 commercial menhaden meals were 13.8, 11.8, 9.5, 5.4, 5.3, 3.0, 2.7, and 2.7. Attempts to relate this variation to known differences in origin, processing, or storage of the meals were unsuccessful.

Experiments involving controlled processing and storage indicated that the unknown growth factor is quite stable. Two samples of menhaden meal were assayed immediately after processing and after storage periods of different lengths under different conditions. Storage in air at room temperature for 18 months did not reduce the growth-factor potency. The potency was not reduced by excessive heat during processing, such as a 3-hour cooking period or a 3-hour drying period at 390° F.

Lest the variation in growth factor potency of fish meals be overemphasized, it should be clearly stated that all of the samples, both commercial and experimental, contained measurable quantities of growth factor.

Experiments on protein quality of fish meals showed that this characteristic was much more easily affected by improper processing than was growth-factor potency. (In these studies, extreme processing conditions were deliberately used in the preparation of the samples.)

This research was financed by funds made available by the Saltonstall-Kennedy Act of 1954 and a contract between the Bureau of Commercial Fisheries and the University of Wisconsin.

FEED FORMULATION UTILIZING A HIGH-SPEED DIGITAL COMPUTER

A high-speed digital computer was used to arrive at detailed and general considerations of least-cost feed formulation.

Since feed manufacturing has become a highly scientific and automated industry, and because many of these new feeds contain a great number of ingredients which provide essential nutrients and must be given proper weighting, new opportunities have developed for high-speed calculations.

Most major ingredients have definite nutritional components and supply varying amounts of essential nutrients. Each ingredient also has a definite cost at any specific time and these costs vary substantially from month to month and from one area to another. Digital computers have made possible the rapid calculation of least-cost formulas through the application of linear programming techniques which, when properly applied, can be of great assistance to the nutritionist both in the determination of least-cost feeds and as a check on the analyses of complex combinations of ingredients.

What is the most practical type of a ration today? In the main we shall refer to broiler, chick or turkey starter rations because we have the most data on these feeds. In most areas corn and soybean oil meal form the basis of practical broiler, chick and turkey starters; hence, we will proceed on this basis.

These two basic ingredients, corn and soybean oil meal, are supplemented by proper additions of known vitamins, minerals, fat for energy, and drugs that have been proven to assist in the control of disease or to stimulate growth.

The New England College Conference Broiler Starter is typical of a highly efficient broiler ration which meets the generally accepted standards for a top quality ration.

On the basis of what we know about nutritional requirements of chicks, if one leaves out the fish meal used in the New England College Conference Broiler Starter, substitutions would be required, but the two rations would have the same approximate nutritional content.

Analyses of the rations show the following differences in ingredients:

REMOVAL OF

Pounds	
100	Fish meal per ton of feed.
129	Ground yellow corn per ton of feed to make room for other necessary additions.
229	

(From the New England College Conference Broiler Starter)

ADDITION TO THE SUBSTITUTE RATION OF:

Pounds	
120	Soybean oil meal per ton of feed to equalize protein.
40	Condensed fish solubles per ton of feed to furnish the fish factor.
13.6	Dicalcium phosphate per ton of feed to furnish the same level of available phosphorus.
50	Fat per ton of feed to equalize the rations in productive energy.
4.4	Calcium carbonate per ton of feed to maintain the same calcium to phosphorus ratio.
1	Methionine per ton of feed to equalize the rations in methionine.
229	

Based on the market of June 8, 1959, costs, f.o.b. Philadelphia or Baltimore, were as follows:

Pounds		Per Ton	
100	Fish meal	@ $133.00 =	$ 6.65
129	Ground yellow corn	54.00 =	3.48
229			$10.13

Pounds		Per Ton	
120	50-percent soybean oil meal	@ $ 73.50 =	$ 4.41
40	Condensed fish solubles	80.00 =	1.60
13.6	Dicalcium phosphate	95.00 =	0.65
50	Fat	140.00 =	3.50
4.4	Calcium carbonate	7.60 =	0.02
1	Methionine	3,100.00 =	1.55
229			$11.73

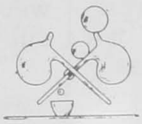
The replacement costs of fish meal can be calculated readily in any area. The comparative values cited apply only on this basis of market values at Lancaster, Penn. Calculations in other areas should be made on actual ingredient costs.

Many products have been offered for sale as substitutes for fish meal that actually were only supposed to contain the unknown growth factor (or factors) in fish meal. One can replace fish meal only by restoring all of the nutritive values that the meal normally supplies.

GAS CHROMATOGRAPHIC STUDIES OF FISH SPOILAGE

Work is in progress to study the chemical nature of fish spoilage with the possible development of an objective index of fish quality or of a means of retarding fish spoilage.

The Bureau's Seattle Fishery Technological Laboratory recently completed the first extensive use of the new technique of gas chromatography to determine volatile acids in fish extracts. They are studying the formation of volatile organic acids during deterioration of fish meat. Acetic and formic acids were the only acids found while the fish were organoleptically acceptable. The sequence of formation of individual acids in fish incubated at 34° F., 40° F., and 70° F. was essentially the same except that propionic acid increased at a greater rate than other acids in the fish incubated at 70° F.



Composition of Some Fishery Products[1/]

Fish	Form	Portion	Calories	Percentage of Protein	Percentage of Fat
Bluefish	baked	4 oz.	193	34	.5
	fried	5.3 oz.	307	34	15
Clams	raw	4 oz.	92	14.5	1.6
	canned	3 oz	44	6.7	0.9
Haddock	fried	4 oz.	166	22.5	6.3
Halibut	broiled	4 oz.	207	29.8	9
Mackerel, Pacific	canned	3 oz.	153	17.9	8.5
Oysters	raw	1 cup	200	23.5	5.0
Salmon	broiled	1 steak	204	33.6	6.7
king	canned	3 oz.	173	16.8	11.2
chum	canned	3 oz.	118	18.3	4.4
silver	canned	3 oz.	140	17.9	7.1
pink	canned	3 oz.	122	17.4	5.3
red	canned	3 oz.	147	17.2	8.2
Sardines, Atlantic	canned in oil	3 oz.	288	17.9	23
Sardines, Pacific	canned, natural	3 oz.	171	15.1	11.5
	canned, tom. sauce	3 oz.	184	15.1	12.6
Shrimp	canned, drained	3 oz.	108	22.8	1.2
Swordfish	broiled	1 steak	223	34.2	8.5
Tuna	canned, oil drained	3 oz.	169	24.7	7.0
	canned, not drained	3 oz.	247	20.2	17.8

1/ Data obtained from USDA Handbook No. 8 Composition of Foods.