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PROGRESS ON INVESTIGATIONS OF NUTRITIONAL VALUE OF FISH-MEAL PROTEIN

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ABSTRACT

The objectives of the investigations reported here were to determine the causes of variability of protein quality in fish meal.

BACKGROUND

A study of the nutritional value of fish meal was begun in 1955 when funds were made available by the Saltonstall-Kennedy Act. As a part of this study, a joint investigation on nutritional value of fish-meal protein was started by the Poultry Husbandry Department, University of California, and the Seattle Fishery Technological Laboratory of the U. S. Bureau of Commercial Fisheries. The objectives of this investigation were (1) to survey the variability of protein quality in commercial fish meals and (2) to determine the causes for the variation.

A detailed report of the survey is given in another paper in this supplement.

The present paper reports progress on the investigation of the causes of the variability. These investigations include studies on (1) effect of raw material and its condition, (2) effect of storage, (3) effect of processing conditions, and (4) development of chick assays to measure "available" amino acids.

EFFECT OF RAW MATERIAL AND ITS CONDITION

Results of preliminary studies on the effect of raw material were described by Grau, Barnes, Karrick, and McKee (1956). These studies were made on tuna. Tests on spoiled and unspoiled, cooked and uncooked material also were made using other species of fish. In each test, meal dried from cooked fish that subsequently was allowed to spoil did not permit growth of chicks. On the other hand, meal prepared (1) from cooked fish that was unspoiled or (2) from raw fish--whether unspoiled or spoiled--permitted good growth.

Attempts now are being made to determine the cause of the detrimental effect of material that is cooked and then spoiled. Studies are being made on extracts of the material, and bacteriological investigations are being started under the supervision of Dr. Reese Vaughn of the Food Technology Department at the University of California.

EFFECT OF STORAGE

A menhaden meal was prepared in a steam-jacketed drier at the Seattle Fishery Technological Laboratory. It is being stored both at room temperature and at

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-20° F. in atmospheres both of air and of nitrogen. After 6 months of storage, the quality of the protein had not deteriorated in meal stored under any of these conditions. The meal will be tested again, however, after longer periods of storage. Storage studies also are being made on commercially-prepared meals.

EFFECT OF PROCESSING CONDITIONS

Studies are under way on the effect of processing conditions on the nutritional quality of fish meals. Meals are prepared in the pilot-plant drier described by McKee and Karrick (1956). Initially, meals were prepared under extreme conditions of cooking, pressing, and drying. Meals dried at 395° F. for 3 hours, when fed as the only source of protein, did not permit chicks to grow.

Time and temperature relationships on the effect of the nutritional value of the protein are being studied. In preliminary studies on the effects of length of time a meal is subjected to a high temperature, one series of meals was dried at 390° F. for time intervals ranging from 15 minutes to 3 hours. In the studies on the effects of temperature, another series of meals was dried for one-half hour at temperature increments of 25° F., ranging from 200° F. to 390° F. Nutritional tests are presently being made on these two series.

Meal dried for a long period of time has a low moisture content. Poor quality of the protein in these meals may be due to (1) damage by heat or (2) the low moisture content. Consequently, an experiment was run to determine whether a meal of low moisture content prepared at relatively low temperatures affected the nutritional value. In this experiment, a meal sample was dried to 10-percent moisture in the drier at 270° F. It then was dried under vacuum at 90° F. to 1.9-percent moisture content. No significant decrease in nutritional value was noted.

DEVELOPMENT OF CHICK ASSAYS FOR "AVAILABLE" AMINO ACIDS

The method that has been used at the University of California to determine the nutritional value of the meals measures the over-all protein value and amino acid balance of the meal. This procedure, however, does not indicate whether an excess of any amino acid exists. Such knowledge is of importance if the fish meal is being used as a supplement for other proteins. Lysine and methionine, for example, often are deficient in the vegetable proteins that furnish most of the protein in practical poultry diets, and an excess of these amino acids in a fish meal therefore improves its value as a supplement. Consequently, work was started to develop chick assays that would determine the amounts of individual amino acids available to the chick. These assays will help to pinpoint differences among meals and will give a quantitative measure of the difference.

The assay now has been found to be successful for lysine, methionine, arginine, threonine, and combined methionine and cystine. It shows promise for histidine, phenylalanine, tryptophane, and combined phenylalanine and tyrosine. The assays are being refined at present. A paper describing the assays has been prepared.

SUMMARY

The objectives of the investigation reported here were to survey the variability of protein quality in commercial fish meals and to determine the causes for these variations. A detailed report of the survey is published elsewhere in this supplement. The research into causes of variations in quality reported in the present paper includes studies on (1) effects of raw material, (2) effects of storage, (3) effects of processing conditions, and (4) development of a chick assay to measure "available" amino acids.

Conclusions have not been reached on the relative importance of any of the causes of variation. The condition of the material used to prepare the meal, however, can cause decreased or even negative growth of the chicks. Studies are being made to determine the cause of this phenomenon.

The presence and availability of individual amino acids are being studied. An important development has been the establishment of an assay to measure in a meal the amounts of individual amino acids that are available to chicks.

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OLD FISH BOXES--BACTERIA UNLIMITED!!

"Bacteria in Fish Boxes" was the title of a report made by R. Spencer in 1955 (The Fishing News, December 30, 1955, p. 5). The data he presented should have frightened every handler of fresh fish. Old fish boxes were loaded with bacteria--the worst enemy of good quality in fresh fish.

The old fish boxes he tested were found to have 450,000,000 bacteria per square inch. After these boxes were cleaned by hosing with water, there were still 175,000,000 (equal to the population of the United States) bacteria per square inch. A strong "chlorine" bactericide, with 1 part of free chlorine per 1,000 parts of water, was not very effective. Even with plenty of scrubbing, these "chlorine" compounds left over 1,000,000 bacteria per square inch, and then after standing 48 hours these bacteria were off on another growing rampage. Bacteria counts around 250,000 per square inch were obtained on old boxes even after thoroughly hosing with water and then steaming for 60 minutes.

Wooden boxes, used only once to ship fish, were well inoculated with bacteria--20,000,000 per square inch. This number was reduced to 2,000,000 by washing with plenty of water. A chlorine bactericide or steaming would lower the number another 90 percent. Even then, there would be a multitude of "seeds" to start rapid spoilage in otherwise good fish.

What about new boxes? The unused, new boxes showed only 70 bacteria per square inch (and these bacteria probably were not mainly spoilage-producing bacteria). Thus a once-used box--remember, used only once--is several thousand times worse than a new box. An old box, even after it is washed well with a hose, has a few million times as many bacteria as a new box. (N. F. I. Flashes, No. 595, December 5, 1958.)