

EVALUATION OF THE BIOLOGICAL VALUES OF THE PROTEINS IN FISH MEALS BY THE NITROGEN RETENTION METHOD¹

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A review of the literature shows the need of detailed information on the biological values of the proteins in fish. Deuel and associates ('46) found that mixed mackerel muscle proteins have a considerably higher biological value than casein. Tuna proteins when fed at 9 and 12% and sardine proteins at 15% also gave considerably more rapid growth in weanling rats than diets containing similar amounts of casein.

Since fish meals, which are by-products of the fish industry, are being used extensively as sources of proteins in animal feeding, it was thought of interest to investigate their biological values. With the cooperation of the By-Products Division of the National Fisheries Institute, Washington, D. C., we were supplied with the following products from various parts of the country: sardine meal; Alaska herring meal; herring meal with fish solubles, which is from a different source than the Alaska herring meal; Red fish meal; Menhaden fish meal; anchovies meal; and crab meal. The fish meals were furnished by the processors in 50-lb. lots selected from several batches; hence the products received constituted representative samples.

The biological values of the proteins in the fish meals were determined by the nitrogen balance method of Mitchell ('24,

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'44), in which the values are expressed as the per cent of absorbed nitrogen retained by the animal. From the biological values and digestibility figures the per cent of net utilization was calculated. Wistar strain albino rats were used and in all of the groups the sexes were divided equally. Each group contained 12 animals. The animals were about 28 days old when started on the experiments and they weighed 50 to 56 gm each. In order to eliminate the influence of the plane of nutrition, we used controlled feeding. Each group was fed the fish meals at an 8% protein level; each animal was given 8 gm daily of its ration which was totally consumed by every rat in the group; therefore, the food intake was constant. Each ration contained an amount of fish meal to provide 8% protein. The rest of the rations contained percentagely cellu flour for roughage, 2; Sure's salts No. 1 ('41), 4; vegetable shortening, 8; cod liver oil, 2; wheat germ oil, 1; and the balance, cerelose. The fat-soluble vitamins A, D, and E were furnished by the cod liver oil and wheat germ oils. The following components of the vitamin B complex were administered separately from the ration 6 times weekly: 25 μ g of thiamine, riboflavin, pyridoxine, and niacin, respectively; 150 μ g calcium pantothenate, 1 mg inositol, 3 mg *p*-aminobenzoic acid, and 9 mg choline chloride.

In order to have information on the biological values of the proteins in fish meals expressed in comparison with efficiency of proteins of known excellent quality, nitrogen retention studies were also carried out on dried whole eggs and on dried non-fat milk solids.

Urinary and fecal balances were carried out for 7 days on an egg standardizing ration and also for 7 days on the experimental rations containing the various fish meals. In each case the animals were allowed to become accustomed to consuming the entire rations for a pre-test period of from three to 5 days before the beginning of the nitrogen balance studies. The percentage composition of the egg ration is as follows: dried defatted whole egg, 5.8; cellu flour, 2.0; Sure's salts No. 1, 4; vegetable shortening, 8.0; cod liver oil, 2; wheat

germ oil, 1; and cerelese, 77.2. The defatted dried whole eggs contained 69.2% protein and furnished 4.0% protein in the ration.

The results of this study are summarized in tables 1 and 2. It will be noted from table 1 that the protein content of the fish meals varied from 35.0 to 69.7%; the fat from 2.1 to 15.3%; the ash from 11 to 29.3%; and the moisture from 2.3 to 8.4%. By varying the amounts of fish meals in the rations it was possible to adjust the protein content to 8% but, because of the great variations in fat content, the rations could not be adjusted on an isocaloric basis; also, because of the great variations in ash, the total mineral content of the rations

TABLE 1
Proximate chemical analyses of fish meals

FISH MEALS	PROTEIN	FAT	ASH	MOISTURE
	%	%	%	%
Alaska herring meal	69.7	8.4	11.0	6.0
Herring meal with fish solubles	52.1	15.3	15.4	8.4
Sardine meal	58.4	3.3	21.8	2.3
Menhaden fish meal	63.4	15.0	15.9	3.3
Red fish meal	57.1	8.1	25.3	6.0
Anchovies meal	50.3	3.3	26.1	6.0
Crab meal	35.0	2.1	29.3	7.0

was also different. However, it is evident from table 2 that the high mineral content of Red fish meal did not interfere with its excellent protein utilization; therefore, the lower net utilization of protein in the crab meal is not due to its high mineral content but rather to its low digestibility. The large standard deviations in the biological value and digestibility of crab meal are due to individual differences in nitrogen retention and digestibility. The standard deviations for digestibilities for Red fish meal and the herring meals seem high, but they are not any higher than that of dried non-fat milk solids. The least standard deviations for biological values and digestibilities were found for the proteins in dried whole eggs.

TABLE 2

The relative biological values of the proteins of various fish meals, dried whole eggs, and dried non-fat milk solids fed at an 8% protein level. Daily food intake, 8 gm. Daily nitrogen intake, 102.4 mg

SOURCE OF PROTEIN	BODY WEIGHT gm	FECAL N ¹ mg	MET. ² N IN FECES mg	FOOD N IN FECES mg	ABSORBED N ³ mg	N IN URINE mg	MET. N IN URINE mg	FOOD N IN URINE mg	FOOD N RE-TAINED mg	TRUE DIGESTIBILITY %	BIOLOGICAL VALUE ⁴	NET UTI-LIZATION ⁴
Sardine meal	72.5	14.9	12.7	2.2	100.2	33.3	19.7	13.0	86.6	97.8	86.4	81.5
Menhaden fish meal	66.5	21.1	10.1	11.0	91.4	33.5	21.5	12.0	79.4	89.2	86.9	77.5
Red fish meal	67.3	23.7	10.2	13.5	88.9	33.8	22.5	11.3	77.6	86.8	87.3	75.8
Alaska herring meal	76.7	20.8	7.7	13.1	89.3	36.9	18.8	18.1	71.2	87.2	79.7	69.5
Herring meal with fish solubles	68.6	20.6	10.0	10.6	91.8	38.7	22.4	16.3	75.5	89.6	82.2	73.6
Anchovies meal	66.6	35.0	11.0	24.0	78.4	35.1	21.5	13.6	64.8	76.6	82.6	63.1
Crab meal	65.9	40.7	10.7	30.0	72.4	32.4	24.4	8.0	64.2	70.7	85.9	60.2
Dried non-fat milk solids	68.9	21.0	10.4	10.6	91.8	30.3	23.1	7.2	84.6	89.6	92.2	82.6
Dried whole eggs	78.8	13.3	11.2	2.1	100.3	25.5	22.0	3.5	96.8	97.9	96.5	94.5

¹ N signifies Nitrogen.

² Met. signifies Metabolic.

³ Per cent of absorbed nitrogen retained in the body.

⁴ The value for the true coefficient of digestibility multiplied by the biological value divided by 100.

It is apparent from table 2 that the proteins of dried whole eggs rank first in efficiency, followed by those of dried non-fat milk solids. However, all of the fish meals have high biological values. The lower net protein utilization of crab meal and anchovies is due to their low true digestibilities. When the net utilization of the proteins in dried whole eggs is taken as 100, those of dried non-fat milk solids are 88.4, and the various fish meals are calculated as follows: sardine meal, 89.4; Menhaden fish meal, 82.0; Red fish meal, 80.2; Alaska herring meal, 73.6; herring meal with fish solubles, 77.9; anchovies meal, 66.7; and crab meal, 63.7.

SUMMARY

A study was made of the biological values of various fish meals by the nitrogen retention method. All of the fish meals were found to have high biological values. However, because of low digestibilities, the net utilization of the proteins in crab meal and in anchovies meal was lower. The biological values were as follows: sardine meal, 86.4; Menhaden fish meal, 86.9; Red fish meal, 87.3; Alaska herring meal, 79.7; herring meal with fish solubles, 82.2; anchovies meal, 82.6; and crab meal, 85.9. When the net protein utilization of dried whole eggs is taken as 100, the various fish meals have the following values; sardine meal, 89.4; Menhaden fish meal, 82.0; Red fish meal, 80.2; Alaska herring meal, 73.6; herring meal with fish solubles, 77.9; anchovies meal, 66.7; and crab meal, 63.7.

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