RAT-FEEDING STUDIES TO DETERMINE NUTRITIVE VALUE OF FISH SCALE PROTEIN [1/]

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ABSTRACT

The nutritive value of both raw ground and hydrolyzed ocean perch and herring scales was studied by means of three rat-feeding experiments. It was determined that scales may not be used as the sole source of protein in the diet, but that they may be used to supplement part of the protein with no loss of nutritive value.

INTRODUCTION

Thousands of tons of fish scales have had to be disposed of as nonutilizable waste during the past several years, since fillets have now replaced round and dressed fish in sales volume. Harbors near fish plants normally allow for a commercially-inexpensive disposal area for scales, but unless tidal flows are strong pollution may result.

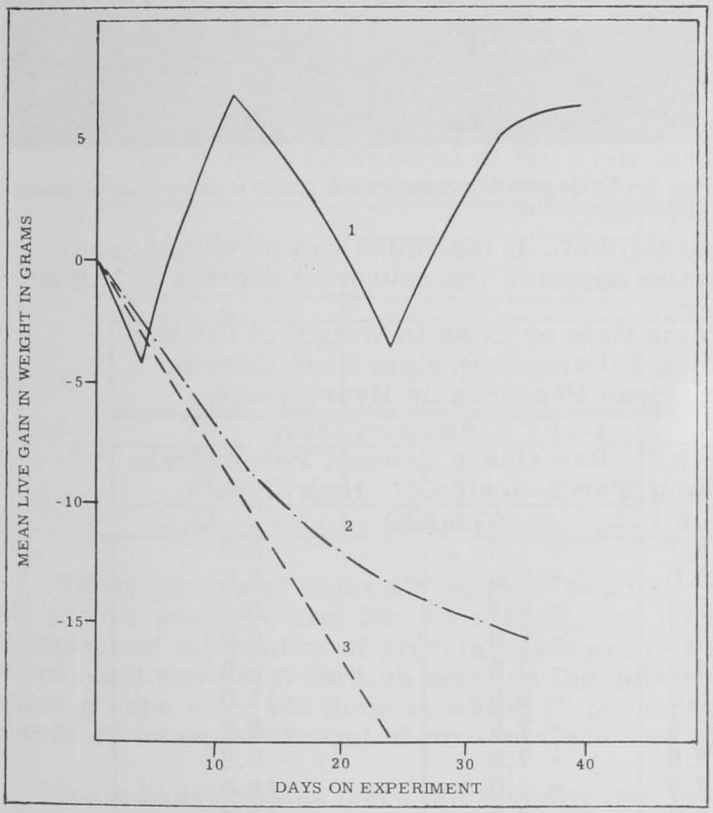

Fig. 1 - Mean daily weight of groups of rats fed diets containing protein from casein (1), raw ground ocean perch scales (2), and a pepsin hydrolysate of these scales (3).

This study has been conducted to determine whether ocean perch (Sebastes marinus) scales can be included to advantage with press cake in the commercial production of fish meal. The feasibility of this possible method of solving the scale-disposal problem requires the determination of the biological values of the protein of the fish meal alone and in various combinations with ocean perch-scale protein.

Fellers et al (1957) reported a method suitable for preparing scale hydrolysates for use in animal-feeding tests, since there is some reluctance on the part of the fish-meal manufacturers to handle the abrasive raw scales due to the poor grinding properties of the scales. This paper, therefore, includes data on the biological values of the protein of pepsin-hydrolyzed scales and of raw scales.

EXPERIMENTAL AND RESULTS

In the first rat-feeding study, the biological value was determined of diets containing the nitrogen compounds in raw ocean perch scales, a hydrolysate from these

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scales, and casein. The method of assay used was one developed by Mitchell and Beadles (1930).

Three groups of 14 post-weaning albino rats each were fed similar isocaloric diets, otherwise nutritionally complete but containing as the only source of protein the casein, scale hydrolysate, or raw scales at levels of 9-percent protein (or equivalents) in the diet. The hydrolysate and raw scales contained 34 and 49 percent of crude protein (N x 6.25), respectively. The feeding period was 6 weeks.

Fig. 2 - Crude protein content of fish scales is determined by Macro-kjeldahl procedure.

The rats of the groups fed the hydrolysate and raw-scale diets lost weight, and nearly all died before the conclusion of the feeding study (table 1, fig. 1). The rats fed the hydrolysate diet lost more weight and died sooner, however, than did those fed the raw-scale diet. It therefore can be concluded (1) that the scale hydrolysate and raw scales alone as the source of protein in another-

Table 1 - Periodic Mean Grams Gain or Loss in Weight of Groups of Rats Fed Diets Containing 9-Percent Protein from Casein, Ocean Perch Scales, or Ocean Perch-Scale Hydrolysate

Time on Experiment	Diet Designation		
	Casein	Raw Ocean Perch Scales	Ocean Perch Scale Hydrolysate
Days	(Grams)		
2	- 6.7	- 7.3	- 5.0
3	-10.0	-10.0	- 6.0
4	- 4.4	- 6.1	- 6.8
5	- 3.0	- 6.0	- 9.0
6	4.5	- 7.5	- 6.0
7	1.0	- 8.0	-11.0
8	6.3	- 7.5	- 8.0
10	- 2.6	- 7.8	- 6.8
11	7.0	- 6.0	-15.0
12	- 1.0	- 8.3	-13.4
13	3.7	- 8.8	- 6.3
14	2.5	- 7.7	-10.0
15	4.7	-11.0	-16.7
16	12.0	- 9.0	-12.0
17	3.0	-10.1	-10.5
19	- 0.5	-19.5	-13.5
20	3.0	-13.0	-
21	0.8	-12.0	- 9.2
24	- 4.0	-18.0	-
28	- 1.0	-13.0	-
30	3.2	-12.2	-
34	6.0	-14.0	-
36	5.0	-13.0	-
42	7.0	-11.5	-

wise nutritionally-complete diet cannot support growth or maintain life of young rats and (2) that raw scales are utilized somewhat better than are the hydrolyzed scales. Either the hydrolysate contains less available nitrogen compounds, or a toxic factor was introduced during the enzymatic hydrolysis of the scales.

The rats fed the casein diet lost, gained, lost, and gained weight (fig. 1). The weight gains that occurred after the weight losses were due to an increase in food made available according to the "paired" method of feeding, since the rats fed the diet containing hydrolysate as a source of protein soon died and were no longer the group that limited food intake. The result of more food being made available to the rats fed the diet containing the raw scales is also evident by the decreasing rate of weight loss for this group (fig. 1). The most pronounced effect of increased food consumption was with the group fed casein.

In the second rat-feeding study, the nutritive value was determined of diets containing fish-meal protein alone and in combination with fish-scale protein. This was done to determine if a possible solution to the fish-scale disposal problem might be found in including them in the production of fish meal.

Table 2 - Periodic Mean Grams Gain in Weight of Groups of Rats Fed a Diet Containing 10 Percent Protein from Fish Meal, and Diets Containing 10 Percent of the Fish-Meal Protein Replaced by Protein from Ocean Perch or Herring Scales

Time on Experiment	Diet Designation		
	Fish Meal	Fish Meal-Ocean Perch Scales	Fish Meal-Herring Scales
Days	(Grams)		
4	5.7	4.7	4.2
11	37.4	36.1	36.9
13	40.3	39.8	39.1
18	53.9	51.7	52.8
32	88.1	85.7	86.6
39	103.7	105.7	102.1
42	108.4	107.4	105.8

Three groups of eight albino post-weaning rats each were used for this test. All groups were fed similar, isocaloric, and nutritionally-complete diets, with the exception of the source of protein. One group was fed a diet containing a total of 10-percent protein from fish meal as the sole source of dietary protein. The two other groups were fed diets in which 10 percent of this fish-meal protein was replaced by an equal amount of protein from raw ground ocean perch or herring scales.

Scale hydrolysates were not investigated in this study, since the previous study indicated that they were not as efficient a source of protein as are the raw scales. The herring (Clupea harengus) scales were compared with ocean perch scales, since they were readily available and would provide additional data on the nutritive value of fish-scale protein. The fish meal and herring scales contained 60 and 70 percent crude protein (N x 6.25), respectively. The feeding study lasted 6 weeks.

A statistical analysis of the data in table 2 indicates that the growth responses of the group of rats fed the various diets were similar. Hence, under the conditions of this experiment, it can be concluded that diets, otherwise nutritionally complete but containing either ocean perch-scale or herring-scale protein in replacement of 10-percent fish-meal protein, are equal in nutritive value to a similar diet containing protein from fish meal alone when both are incorporated at a level of 10-percent protein in the diet.

These results necessitated an investigation of the nutritive value of similar diets containing a higher percentage of the dietary protein supplied from fish scales in place of equal amounts of fish-meal protein. Thus, the third test included a diet containing 9-percent protein from fish meal as the only source of dietary protein and two diets in which 30 percent of this fish-meal protein was replaced by protein from the perch and herring scales, respectively. Six post-weaning albino rats were allotted to the groups fed the three diets. The test lasted 6 weeks.

Table 3 - Periodic Mean Grams Gain in Weight of Groups of Rats Fed a Diet Containing 9-Percent Protein from Fish Meal, and Diets Containing 30 Percent of the Fish Meal Protein Replaced by Protein from Ocean Perch or Herring Scales

Time on Experiment	Diet Designation		
	Fish Meal	Fish Meal-Ocean Perch Scales	Fish Meal-Herring Scales
Days	(Grams)		
9	14.1	8.3	10.7
14	34.4	24.0	27.2
21	57.9	45.3	49.3
26	63.2	51.7	55.5
35	79.9	68.0	71.2
37	83.6	68.8	73.5
42	95.9	80.3	86.0

The data in table 3 indicate that the gain in weight of the group of rats fed the diet with fish-meal protein was not significantly different statistically from that of the group fed the diet containing herring scales as 30 percent of the dietary protein. The gain in weight of the group of rats fed the diet containing 30 percent of the protein from perch scales, however, was significantly different statistically from that of the group fed the fish-meal diet. The data therefore indicate that a diet otherwise nutritionally complete but containing herring-scale protein in replacement of 30 percent fish-meal protein is equal in nutritive value to a diet containing protein from fish meal alone when both are incorporated at a level of 9-percent protein in the diet. A diet containing ocean perch-scale protein in replacement of a similar amount of fish-meal protein, however, is poorer in nutritive value.

SUMMARY AND CONCLUSIONS

Three rat-feeding studies were conducted according to a method developed by Mitchell and Beadles (1930). The first test included as sources of protein the nitrogen compounds in raw ocean perch scales, a hydrolysate from these scales, and casein. The second and third tests included the protein from fish meal, and various combinations of fish meal and perch or herring scales. Under the conditions of the experimental procedure described herein, the data from this study indicate the following:

1. Young rats do not grow or even live when fed raw ground ocean perch scales or a pepsin hydrolysate of these scales as the sole source of protein at a 9-percent level in an otherwise nutritionally-adequate diet. The nutritive value of the ground-scale protein is somewhat better, however, than is that of the hydrolyzed-scale protein.

2. Diets, otherwise nutritionally complete but containing herring-scale protein in replacement of up to 30-percent fish-meal protein, are equal in nutritive value to a similar diet containing protein from fish meal alone when both are incorporated at a level of 10-percent protein in the diet.

3. Similar diets containing ocean perch-scale protein in replacement of 10-percent fish-meal protein are equal, but 30-percent replacement is poorer in nutritive value than is a diet containing protein from fish meal alone when both are incorporated at a level of 9-percent protein in the diet.

LITERATURE CITED

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