THE CHEMICAL AND NUTRITIVE CHARACTERISTICS OF HERRING MEALS PRODUCED ON THE ATLANTIC COAST OF CANADA

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FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 114

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Abstract

A study has been conducted on the nutrient composition of Atlantic Coast herring meals produced in the 1966-67 season. Analytical data reported are: Moisture, ether extract, protein, ash, vitamins, minerals, salt, amino acids, protein digestibility, available lysine, supplementary protein, metabolizable energy and water soluble proteins.

Introduction

The production of herring meal and oil on the Atlantic Coast of Canada has increased rapidly during the past few years, thus contributing substantially to the income of the Fishing Industry.

TABLE I

ATLANTIC COAST PRODUCTION OF HERRING OIL AND MEAL

	1962	1963	1964	1965	1966	1967	1968
Herring oil (thousands of pounds)	1545	1400	4730	7140	15,811	39,053	67,400
Herring meal	4375	4667	6247	12,783	25,881	48,843	86,539

A number of new reduction plants have been built, greatly increasing the total processing capacity (Table I). Modern purse seiners have been introduced into the fishery, many of them brought over from British Columbia where the herring fishing season has been closed to allow the stocks to recover. More than 130 boats, many of them midwater trawlers, are at present engaged in the Atlantic herring fishery.

The occurrence of herring at any point on the Canadian Atlantic coast is not continuous but varies with the time of the year. In recent years commercial catches have been made off the West and South Coasts of Newfoundland from November to April, near the Magdalen Islands in April-May and off Northern New Brunswick and Southwestern Nova Scotia from May through September. The herring landed in Southern New Brunswick throughout the year are mainly small fish used for the production of sardines.

In 1962, the Vancouver Laboratory of the Fisheries Research Board of Canada published a circular describing the nutrient composition of British Columbia herring meal.[1)] Recently a publication appeared covering Canadian

1) March, B.E., Jacob Biely and H.L.A. Tarr. Nutrient Composition of British Columbia Whole Herring Meal. Circular No. 26, Technological Station, Vancouver. September, 1962.

freshwater fish.[2] These publications have been very much in demand by nutritionists and feed compounders. The current study was undertaken in order to provide the analytical data on the Atlantic Coast herring meals.

Sampling

All plants producing herring meal on the Atlantic coast of Canada were asked to provide representative samples of each days production along with the daily production quantities. Samples were collected between November, 1966 and November, 1967. The samples were stored individually in polyethylene bags at room temperature until blended to form composite samples. The daily samples were blended, under nitrogen, to form representative composite samples of Atlantic coast production as shown in Table II and shipped immediately to the laboratories for analysis.

The sampling procedure used has masked any variation in the meals due to processing methods used by individual processors. However, the chemical analysis and biological values of the meals would reflect both the effects of seasonal physiological variations in the raw material and the effect due to changing fishing areas as the processing season progresses. These last two factors do not appear to have any significant effect on the characteristics of the meals as they are reasonably consistent over the entire processing season.

Analytical Data

Standard analytical procedures were used in connection with all the determinations. The exact methods are described in the references which are

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2) March, B.E., Jacob Biely, E.G. Bligh and A.W. Lantz, Nutrient Composition of Freshwater Fish Meals. Feedstuffs, Vol. 39, No. 46, p. 50.

listed in Table III. In several cases determinations were made by two procedures and are given separately. The analytical results are tabulated in Tables IV to XI and were appropriate, average analyses with standard deviation calculated.

From Tables IV and VI it can be seen that there is a considerable variation in the contents of water soluble proteins and vitamins in the seven pooled samples. This is due to the fact that at the time of sampling, two or three of the major producers did not have evaporators installed to concentrate the stickwater. Consequently, most of the water soluble material was discarded. This has since been partly remedied, and only one of the major producers is still not producing "whole meal".

The proximate analysis is given in Table V. The moisture content averaged 6.7%, the ether extract (fat content) 8.9% and the ash 10.4% which is in accord with similar meals from other areas. The protein contents were fairly uniform in the samples at 71.57%.

The mineral elements are given in Table VII and indicate that Atlantic herring meals are an excellent source of trace minerals. We have no ready explanation for the large variations in iodine content.

Table IX shows the amino acid composition as determined on the amino acid analyzer. The composition compares favorably with herring meals from British Columbia and Norway.

The values for Supplementary Protein (Table XI) and Metabolizable Energy (Table XII) were determined from biological assays carried out at the University of British Columbia. The M.E. value found in sample 4 is low and could be due to problems associated with the initial operation of equipment for the addition of antioxidant.

Conclusions

In chemical composition and nutritive value herring meals produced on the Atlantic Coast of Canada compare favorably with other fishmeals and particularly with herring meal produced on the Pacific Coast. With one or two exceptions there were no significant differences in the composition or biological values in the seven composite samples used in this study.

Acknowledgments

The authors would like to acknowledge the co-operation of the Atlantic coast herring meal producers in supplying samples from their daily production for use in this study. Mrs. R.E. Sinclair, Mrs. P. Seaman and Mr. C.A. Campbell gave valuable assistance in preparing samples for analysis and in organization of data. Mr. P.M. Jangaard, Scientific Liaison Officer with the Halifax Laboratory of the Fisheries Research Board of Canada provided very valuable assistance in collection of samples and with advice on organization and presentation of this report. Chemical analysis of the samples was done by The Wisconsin Alumni Research Foundation, Madison, Wisconsin and the Fisheries Research Board of Canada, Halifax Laboratory.

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TABLE II

Sample No.	Period Produced	Production Area
1	Nov. 28, 1966 - April 28, 1967	all from south coast of Nfld.
2	Apr. 27, 1967 - May 23, 1967	mainly from Magdalen Islands, Northern New Brunswick.
3	June 2, 1967 - June 18, 1967	mainly from Magdalen Islands, Northern New Brunswick.
4	July 2, 1967 - July 21, 1967	mainly southern Nova Scotia and Northern New Brunswick.
5	Aug. 3, 1967 - Aug. 9, 1967	mainly from southern Nova Scotia.
6	Aug. 23, 1967 - Sept. 2, 1967	mainly from southern Nova Scotia.
7	Sept. 18, 1967 - Nov. 2, 1967	mainly from southern Nova Scotia.

TABLE III

Methods of Analysis

Amino Acid analysis	- [1] Moore, Stein and Spackman, Anal. Chem. 30, 1190-1206, 1958. [2] Henderson and Snell, J. Biol. Chem. 172, 15, 1948.
Thiamine	- A.O.A.C., 758 (1965) 10th Ed.
Riboflavin	- A.O.A.C., 773 (1965) 10th Ed.
Pantothenic Acid	- Nielands and Strong, Arch. of Biol. 19, 2, 1948.
Niacin	- A.O.A.C., 771 (1965) 10th Ed.
Choline	- Horowitz and Beadle, J. Biol. Chem. 150, 325, 1943.
Biotin	- Wright and Skeggs, Proc. Soc. Exp. Biol. and Med., 56, 94, 1944 (L. Arabinosus).
Folic Acid	- A.O.A.C., 770 (1965) 10th Ed.
Vitamin B-12	- U.S.P. XVII 864, 1965.
Vitamin K	- Biological: Almquist, Biol. Symposia Vol. III, 508, 19

Methods of Analysis (Cont'd)

Moisture	- A.O.A.C., 327 (1965) 10th Ed.
Protein	- A.O.A.C., 16 (1965) 10th Ed.
Ether Extract	- A.O.A.C., 331 (1965) 10th Ed.
Fiber	- A.O.A.C., 332 (1965) 10th Ed.
Ash	- A.O.A.C., 328 (1965) 10th Ed.
Elemental	- Jarrel-Ash Direct Reading Spectrometer. Computer Application for Direct Concentration Print Out of Plant Tissue Analysis by Emission Spectroscopy by R.E. Christensen et al., presented at the Pittsburg Conference, March, 1967.
Calcium	- [3]A.O.A.C., 26 (1965) 10th Ed.
Phosphorus	- [4]A.O.A.C., 13 (1965) 10th Ed.
Sodium Chloride	- A.O.A.C., 273 (1965) 10th Ed.
Iodine	- A.O.A.C., 341 (1965) 10th Ed. Binnents Analytical Chemistry, Acta 10, 1954.
Sulphur	- Soil Science Soc. of American Proc. 29(1965) p. 71.
Cobalt	- Sandell, Determination of Traces of Metals p. 415 (1959)
Molybdenum	- A.O.A.C., 105 (1965) 10th Ed.
Hot Water Soluble Protein	- 10 g sample + 100 ml water (60-65°C) were mixed and stirred for 30 min. Loss of water due to evaporation was corrected by adding extra water. Mixtures were centrifuged at 2000 rpm for 30 min., filtered through Whatman No. 1 Filter papers. 10 ml of filtrate was evaporated to dryness at 100°C for the determination of solubles. Protein-Nitrogen was determined in the filtrate by using the Biuret method.

1) 2) 3) 4) Analysis of meal for calcium, phosphorus, cystine, methionine and tryptophan were done by two different methods of analysis denoted by the numbers.

Methods of Analysis (Cont'd)

Pepsin digestibility - A.O.A.C., 330 (1965) 10th Ed.

Available lysine - Carpenter, K.J., Biochem. J. 77: 604-610 (1960).

Supplementary Protein Value - March, B.E., J. Biely, C. Goudie and H.L.A. Tarr. J. Fish. Res. Bd. Canada 23: 395-414 (1966).

Metabolizable Energy Value - March, B.E., J. Biely, H.L.A. Tarr and F. Claggett. Poultry Science 44: 679-685 (1965).

TABLE IV

Hot Water Soluble Protein in Atlantic Coast Herring Meals

Sample No.	Hot water soluble protein (% of meal)	Hot water soluble protein (% of total crude protein)
1	7.37	10.0
2	5.82	7.7
3	3.44	4.7
4	7.0	9.7
5	6.44	8.8
6	6.5	8.8
7	5.56	7.5

Chemical Analysis

TABLE V

Proximate Analysis of Atlantic Coast Herring Meals

Sample No.	Moisture %	Ether Extract %	Protein %	Ash %
1	6.1	9.4	73.7	10.6
2	5.9	7.5	75.2	10.0
3	7.1	9.9	72.7	10.3
4	7.5	8.3	72.5	10.4
5	7.1	8.1	73.1	10.4
6	6.7	9.2	74.3	10.6
7	6.5	9.8	73.8	10.4
Average with Standard Deviation	6.7	8.89 $\pm$ .922	73.6 $\pm$ .945	10.4 $\pm$ .202
Average for B.C. Herring Meal	7.74	7.9	71.57	11.04

TABLE VI

Vitamin Analysis of Atlantic Coast Herring Meals (mg/100 g)

mple No.	1	2	3	4	5	6	7	Average with Standard Deviation	Av B.
iamine	0.03	0.02	<0.01	0.02	0.04	0.05	0.03	---	
boflavin	0.762	0.54	0.595	0.730	0.575	0.575	0.590	0.623 ± .077	
ntothenic Acid	1.83	0.511	0.631	1.57	1.17	1.68	1.65	1.29 ± 0.53	
acin	11.0	8.08	5.73	11.0	11.6	10.9	11.9	10.03 ± 2.27	
oline Chloride	770	584	446	656	652	636	702	635 ± 101	
otin	0.0373	0.0418	0.0400	0.0432	0.0440	0.0414	0.0420	0.041 ± .002	
lic Acid	0.0398	0.0248	0.0324	0.0273	0.0261	0.0258	0.0291	0.293 ± .005	
amin B-12	0.0303	0.0264	0.0271	0.0260	0.0251	0.0258	0.0261	0.027 ± .001	
amin K tivity/g)	<20	11.8	4.0	13.2	15.7	15.1	12.2	---	<

Choline

ng/100 g

TABLE VII

Mineral Content of Atlantic Coast Herring Meals

Sample No.	1	2	3	4	5	6	7	
Calcium, (%)	2.2	2.1	2.6	2.0	1.9	2.0	1.9	2
Calcium, (%)*[3]	2.5	2.8	3.0	2.6	2.5	2.8	2.6	2
Phosphorus, (%)	1.9	1.8	2.0	1.8	1.8	1.8	1.7	1
Phosphorus, (%)*[4]	2.5	2.4	2.6	3.0	2.5	3.0	2.4	2
Sodium, (%)	0.56	0.49	0.73	0.57	0.65	0.65	0.64	0
Potassium, (%)	1.1	1.1	1.1	1.4	1.4	1.4	1.2	1
Magnesium, (%)	0.11	0.14	0.15	0.17	0.17	0.17	0.15	0
Sulphur, (%)	1.1	0.86	0.90	1.12	0.83	1.11	0.67	0
Iron, (ppm)	107	125	180	100	85	100	125	1
Copper, (ppm)	6.2	4.6	5.1	3.3	5.1	4.6	1.6	4
Manganese, (ppm)	< 2.0	4.4	7.1	< 2.0	< 2.0	< 2.0	< 2.0	
Zinc, (ppm)	146	119	112	103	99	104	99	1
Iodine, (ppm)	126	42	1.4	1.5	1.6	34	1.3	
Cobalt, (ppm)	0.18	< 0.1	0.13	< 0.1	< 0.1	< 0.1	< 0.1	
Molybdenum, (ppm)	0.19	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	

TABLE VIII

Salt Content of Atlantic Coast Herring Meals

Sample No.	NaCl %
1	1.47
2	1.00
3	1.61
4	1.29
5	1.56
6	1.44
7	1.53
Average with Standard Deviation	1.41 ± .21

TABLE IX

Amino Acid Analysis (grams per 100 grams protein) of A

	Sample No.					
Acid	1	2	3	4	5	6
ne	7.29	8.32	8.28	7.96	8.31	8.64
idine	2.55	3.18	3.33	3.33	3.27	3.37
nine	5.52	6.96	6.94	6.07	6.35	6.58
tic	10.3	9.60	10.0	9.40	9.71	9.73
nine	5.78	4.33	4.49	4.17	4.20	4.33
ne	3.87	3.95	4.14	3.81	3.91	4.05
mic	10.6	13.2	13.9	12.2	13.1	13.3
ine	4.64	4.68	4.21	4.56	3.78	4.68
ine	6.23	4.79	5.68	5.29	5.45	5.57
ine	6.55	6.53	6.84	6.27	6.63	6.43
ine	1.05	0.921	0.985	0.903	0.925	0.832
ine[2]	---	1.03	1.10	1.041	1.56	1.00
ne	5.48	5.27	5.49	5.12	5.08	5.30
ionine	2.88	2.80	3.04	2.86	2.87	2.97
ionine[2]	---	2.48	2.82	2.72	2.53	2.62
eucine	3.89	4.39	4.68	4.31	4.26	4.47
ine	7.25	8.01	8.32	7.76	7.82	7.97
sine	3.04	3.47	3.63	3.33	3.30	3.38
ylaline	3.89	4.02	4.27	3.93	3.98	4.16
tophan	1.24	1.38	1.47	1.35	1.32	1.37
tophan[2]	---	1.33	1.57	1.26	1.44	1.47

analyses by method 1 except as noted.

Nutritive Value of Atlantic Herring Meal

TABLE X

Protein Digestibility and Available Lysine of Atlantic Coast Herring Meals

ple	Percent of Crude Protein		Available Lysine	Available Lysine
	pepsin (0.2%)* digestibility	pepsin (0.002%)* digestibility	% of meal	g/100 g protein
1	94.7	91.6	6.1	8.3
2	93.9	90.4	5.5	7.3
3	94.5	90.7	5.7	7.8
4	94.7	91.7	6.2	8.6
5	94.4	90.0	5.5	7.5
6	94.1	88.6	5.4	7.3
7	95.4	91.2	5.6	7.6
rage with ndard Deviation	94.5 ± .49	90.6 ± 1.08	5.7 ± .31	7.8 ± .50
rage of B.C. ring Meals	92.4	—	—	7.0

Using 0.2 and 0.002% of a 1:10,000 preparation.

TABLE XI

Supplementary Protein Values of Atlantic Herring Meal

Sample No.	S.P.V. 4% *	S.P.V. 8% *
1	132	108
2	129	109
3	126	112
4	126	109
5	132	117
6	131	113
7	123	109
Average with Standard Deviation	128.4 ± 3.5	111 ± 3.2

* The test meals were in the diets to supply 4 and 8% respectively of protein

TABLE XII

Atlantic Herring Meal

Metabolizable Energy Values (Kcal/lb dry weight basis)

Sample No.	M.E. Value with Standard Deviation
1	1640
2	1575
3	1580
4	1425
5	1540
6	1625
7	1622
Average with Standard Deviation	1572 ± 73.8