VITAMIN CONTENT OF FISHERY BYPRODUCTS

Part 1 - Effect of Processing Methods on Riboflavin, Nicotinic Acid, and Vitamin B_{12} Content of Solubles and Meal

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INTRODUCTION

Fish meal and condensed fish solubles, in addition to their content of high-quality protein, contain a number of vitamins which add materially to their nutritive value. Very little has been known either about the losses of such vitamins in the manufacture of these products or about the relative distribution of the vitamins between the meal and the solubles. The authors have investigated such losses and the distribution of riboflavin, nicotinic acid, and vitamin B_{12} in the manufacture of California pilchard meal.

SAMPLING PROCEDURES

Samples of press cake, of the meal prepared from this press cake, and of stickwater from the press were obtained from three reduction plants. On the days when samples were taken these plants were operating as follows: Plant A was drying pilchard and mackerel canning scrap in a direct flame dryer. Plant B was drying whole pilchard in an indirect flame dryer at approximately 250° F. Plant C was using pilchard scrap and drying the meal in an air-lift dryer at approximately 175° F.

Five samples each of press cake, meal, and stickwater were taken during one day's run at each plant. Since it is difficult to be certain just how representative a given sample may be of the material flowing through a plant during a day's operation, the five samples of each product were taken in order to check on the variation during a day's run.

All samples were stored at 0° F. until the analyses were made. The meals were ground in a "Labconco" laboratory mill before analysis.

ASSAY METHODS

The vitamin content of the products was determined by microbiological assays. A modification of the method of Roberts and Snell (1946) was used for the riboflavin and the nicotinic acid assays. Vitamin B_{12} was determined by a modification of the method of Hoffmann, Stokstad, Hutchins, Dornbush, and Jukes (1949).

Riboflavin and nicotinic acid were extracted by incubating 1-gram samples with papain and takadiastase in a pH 4.6 buffer at 37° C. Vitamin B_{12} was extracted by autoclaving the sample in water at 15 pounds pressure for 5 minutes.

For all of the vitamin assays the samples were run in duplicate at 4 levels. The growth of the organism was measured by titration of the acid produced. Each sample was analyzed 6 to 10 times for each of the vitamins.

Oil and moisture content of the products was determined using standard technics of the A. O. A. C. (1950).

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DISCUSSION OF RESULTS

The five samples of press cake and meal taken from plant A were assayed separately to determine the variation during a day's run. There was significant but small variation in the moisture and fat content (table 1). The data indicate that the products during a day's run vary slightly but are fairly uniform from the standpoint of moisture and fat content.

Table 1--Variation in Moisture, Oil, and Vitamin Content of Press Cake and Meal During One Day's Operation

Plant Code	Type of Dryer	Raw Material	Processed Material	Sample	Composition of Sample: Moisture	Oil	Vitamins (moisture- and oil-free basis): Riboflavin	Nicotinic Acid	B_{12}
				Number[1]	Percent	Percent	Micrograms Per Gram	Micrograms Per Gram	Micrograms Per Gram
A	Direct flame dryer	Pilchard and mackerel canning scrap	Press cake	1	57.3	5.47	6.7	92	0.29
				2	54.5	5.48	6.2	88	0.32
				3	55.8	4.87	4.7	85	0.29
				4	57.0	6.48	2.8	93	0.37
				5	57.8	5.45	3.0	91	0.36
			Meal	1	8.9	9.21	4.5	71	0.34
				2	7.9	9.24	4.5	60	0.32
				3	8.2	8.06	4.5	65	0.26
				4	8.9	7.88	4.8	71	0.28
				5	8.0	8.48	4.3	62	0.25
C	Air-lift dryer (app. 175° F.)	Pilchard scrap	Meal	1	12.5	7.15	2.9	42	0.22
				2	13.4	7.09	2.4	44	0.23
				3	12.9	7.13	2.5	42	0.21
				4	14.1	6.94	2.8	43	0.23
				5	13.4	6.52	2.5	40	0.22

1/EACH NUMBER REPRESENTS A SEPARATE SAMPLE TAKEN DURING THE COURSE OF A DAY'S OPERATION.

There was no significant variation in the nicotinic acid and vitamin B_{12} content among the replicate samples of press cake and meal. The riboflavin content among the replicate samples of meal was uniform, but the riboflavin content of the press cake replicate samples showed considerable variation (table 1). Since the variability among samples from plant A was not great, samples from plant B, where similar processing technics were used, were not assayed separately but were composited. Meal samples from plant C, where different equipment was used, were assayed individually.

DRYING LOSSES: In the preparation of meal from pilchard and mackerel canning scrap in a direct flame dryer, whole pilchard in an indirect flame dryer, or pilchard scrap in an air-lift dryer, there was no significant loss of riboflavin and vitamin B_{12} during the drying process from press cake to meal (table 2). There was also no loss

Table 2--Composition of Press Cake and of the Corresponding Meals in Different Types of Dryers

Plant Code	Type of Dryer	Raw Material	Processed Material	Composition of Sample[1]: Moisture	Oil	Vitamins (moisture- and oil-free basis): Riboflavin	Nicotinic Acid	B_{12}
				Percent	Percent	Micrograms Per Gram	Micrograms Per Gram	Micrograms Per Gram
A	Direct flame dryer	Pilchard and mackerel canning scrap	Press cake	56.5	5.55	4.7	90	0.33
			Meal	8.4	8.57	4.5	66	0.29
B	Indirect flame dryer (app. 250° F.)	Whole pilchard	Press cake	53.6	4.80	3.8	82	0.23
			Meal	7.5	7.85	3.8	80	0.24
C	Air-lift dryer (app. 175° F.)	Pilchard scrap	Press cake	49.5	4.11	2.8	39	0.18
			Meal	13.3	6.96	2.6	42	0.22

1/DATA FOR A PRESS CAKE AND MEAL, AND FOR C MEAL REPRESENT THE AVERAGE OF FIVE INDIVIDUAL SAMPLES TAKEN DURING THE COURSE OF ONE DAY'S OPERATION IN A PLANT. DATA FOR B PRESS CAKE AND MEAL, AND FOR C PRESS CAKE REPRESENT THE AVERAGE VALUES FOR COMPOSITE SAMPLES PREPARED BY COMBINING FIVE SAMPLES TAKEN DURING THE COURSE OF A DAY'S PLANT OPERATION.

of nicotinic acid in the pilchard meal prepared both in an air-lift dryer and an indirect flame dryer. However, there was a signigicant difference in nicotinic acid content between the press cake and the direct flame-dried meal. The nicotinic acid content of the press cake varied from 85 to 93 micrograms per gram on the dry basis and averaged 90, while that of the meal ranged from 60 to 71 and averaged 66. The average loss in nicotinic acid content amounted to 27 percent.

It has been quite generally believed that rather extensive losses of nutritive value occur when press cake is dried, especially in dryers of the direct-flame type. It is surprising to note, therefore, that neither vitamin B_{12} nor riboflavin show any appreciable decrease when the press cake is processed in such a dryer.

VITAMIN DISTRIBUTION BETWEEN MEAL AND SOLUBLES: Some tests were carried out to show the distribution of the three vitamins between the meal and the solubles. The original raw material contains a certain quantity of each of the vitamins. At the pressing stage a portion of the vitamins are diverted into the stickwater, and these vitamins eventually appear in the condensed fish solubles. The remainder of the vitamins stay in the press cake and, aside from any losses in the dryer, end up in the finished meal. In order to calculate this distribution it is necessary to know the proportion of meal and solubles produced from a given quantity of raw material. For this purpose the ratio 400 pounds of meal to 165 pounds of solubles (50 percent solids) per ton of raw material were used. These figures were averages of values obtained from several operators of pilchard reduction plants.

In the analyses of the fish solubles used for the distribution calculations, all assays were made on the uncondensed fish solubles as they came from the press. These solubles contained about 5 percent solids and had yet to be concentrated to produce the condensed product. During this subsequent concentration some loss of vitamin content possibly occurs. It was impractical, however, to procure samples of the condensed fish solubles corresponding to the lots of meal prepared from the same raw material. The dilute solubles are stored in large tanks in which stickwater from several days' production is collected. Thus, any sample of condensed solubles would correspond to stickwater from several days' operations.

The distribution of vitamins between solubles and meal takes place at the pressing stage. Plants A and B employed the same type of press, whereas plant C used a different type. The meal manufactured at plant C contained a higher proportion of all three vitamins in the meal than did products from the other two plants. Therefore, it may be that the distribution of these vitamins between the meal and the solubles is affected by the manner of pressing.

Table 3--Distribution of Vitamins Between Solubles and Meal

Plant Code	Raw Material	Processed Material	Vitamins Derived From 1 Ton of Raw Fish					
			Riboflavin		Nicotinic Acid		Vitamin B12	
			Quantity	Proportion	Quantity	Proportion	Quantity	Proportion
			Micrograms	Percent	Micrograms	Percent	Micrograms	Percent
A1/	Pilchard and mackerel canning scrap	Solubles	880	56	25,500	72	57	57
		Meal	680	44	9,900	28	43	43
		Solubles and meal	1,560	100	35,400	100	100	100
B2/	Whole pilchard	Solubles	740	56	28,500	70	89	71
		Meal	580	44	12,100	30	36	29
		Solubles and meal	1,320	100	40,600	100	125	100
C3/	Pilchard scrap	Solubles	300	45	9,100	60	24	43
		Meal	370	55	6,140	40	32	57
		Solubles and meal	670	100	15,240	100	56	100
Over-all average in solubles			640	52	21,000	67	57	57

1/PLANT A USED A FLAME DRYER AND STANDARD SCREW-TYPE PRESS.
2/PLANT B USED A MODIFIED FLAME DRYER AND STANDARD SCREW-TYPE PRESS.
3/PLANT C USED AN AIR-LIFT DRYER AND P. & E. TYPE PRESS. A ROUGH MEASURE OF THE VITAMIN CONTENT OF THE RAW MATERIAL PROCESSED IN PLANT C INDICATED THAT THIS RAW MATERIAL WAS MUCH LOWER IN THE CONTENT OF ALL 3 VITAMINS THAN THAT ENTERING OTHER PLANTS. THIS PROBABLY ACCOUNTS FOR THE MUCH LOWER VALUES FOUND FOR PRODUCTS FROM PLANT C RATHER THAN ANY DIFFERENCES DUE TO PROCESSING METHODS.

Riboflavin was about evenly distributed between the solubles and the meal (table 3). The proportion in the solubles ranged from 45 to 56 percent of the total with an average of 52 percent. About two-thirds of the nicotinic acid occurred in the solubles with a range of from 60 to 72 percent and with an average of 67 percent. The distribution of vitamin B_{12} was quite variable, ranging from 43 to 71 percent.

Of the total amount of these three vitamins in the meal and the solubles, an over-all average of 59 percent occurred in the solubles and 41 percent in the meals. In operations where the solubles are added back to the meal to produce a "whole meal," it should be possible to about double the content of these vitamins over the concentration occurring in regular meal.

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SHIPWORM FRITTERS--A DELICACY

"I firmly believe one of the finest dishes in all the world is a platter of fried shipworm fritters," says an employee of the Maryland Chesapeake Biological Laboratory. "They taste like a delicate combination of the best clams and oysters," he says. Two employees of the Laboratory have been making an extensive study of these destructive sea animals.

"The big problem in making the fritters," says the second employee, "is getting enough shipworms. We cut them out of wooden blocks that have been purposely exposed to the worms, and sometimes it's a pretty exhausting operation."

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