INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON

No. 15

Studies on Practical Diet for Fingerling Chum Salmon, *Oncorhynchus keta*.

By

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and

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"INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON"

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ABSTRACT

In a 4 week feeding experiment, fingerling chum salmon weighing 12 grs., were fed 4 diets containing different chilean fish meals as a protein source. Fish meals used in this experiment were as follows; white fish meal for diet W-1 was manufactured by factory ship stationing along the coast of Chile using mainly meruluza as a raw material.

Brown fish meals for diets B-1 and B-2 were manufactured by factories in the eighth region using horse mackerel as a raw material and B-3 from the first region using spanish sardine.

The fish fed W-1 showed the best growth and feed efficiency. Protein and fat contents in whole body of the fish fed this diet were also higher than the remmaining three groups fed brown fish meal diets.

Remarkably high peroxide value (214) and low level of highly unsaturated fatty acids were noted in the brown fish meal B-2.

The worst growth and feed efficiency were obtained by feeding the diet B-3 whose fish meal had the lowest ratio (0.62) of ether extract / methanol-chloroform extract.

INTRODUCTION

Introduction of Pacific Salmon into Aysén, Chile, was initiated in 1973 as a cooperative project between Chile and Japan, but only unfed fry released in the autum til 1976. The first feeding trial for chum salmon fry was conducted in 1977 and fairly good growth was obtained in spite of low water temperature. (Nagasawa and Novoa, 1980).

Encouraged by this results, the decision was made to release most of fingerlings in springtime after about six month feeding with a japanese commercial feed for rainbow trout.

With increasing number of fry to be fed, the amount of fish feed also increased year by year and it can be estimated to reach nearly 100 tons in 1986.

While fish meal production in Chile increased about 9-fold during last decade and more than 0.8 million tons of fish meal was manufactured in 1983, but about 98% of the product was exported to foreign countries as a feedstuff for land animals. Since fish culture has been attracting attentions in Chile where are great potentials for a development of aquaculture industry, it is necessary to find out suitability of various chilean fish meals as a major protein source for fish feed not only for development of feed needed in this project, but also for further development of aquaculture industry in Chile.

Quality of chilean brown fish meals manufactured in the first and second regions has been proved to be good enough as a protein source of rainbow trout feed (Takeuchi and Martens, 1983). Also fingerling chum salmon fed the diet with white fish meal manufactured by a factory ship stationing along the coast of Chile could achieve a comparable performance to those fed a japanese commercial trout feed. However the results of the study using brown fish meals obtained from the eighth region indicated that quality of these were conspicously poor judging from growth rate and feed convertion. (Authors, in press).

In this study, quality comparison of 4 different fish meals was made based on chemical analyses and feeding experiment.

MATERIALS AND METHODS

Table 1. Experimental condition.

Water temperature	5.2 - 16.8°C
Experimental period	4 weeks (5 - 31, March, 1984).
Experimental tank	PVC tank (30 x 65 x 35 cm).
Initial number of fish	30
Initial mean weight	12 grs.
Water supply	2.0 lt/min.
Feeding	3 times/day. 6 days/week, to satiation.

The experimental conditions are shown in Table 1. The fish used for the experiment were artificially propagated at Dr. Shiraishi Hatchery, Coyhaique, in May 1983. They were fed on a japanese commercial trout feed for seven months. Fish weighing about 12 grs were selected and divided into 8 groups. The fish were weighed individually at the begining and end of the experiment after being anesthetized with 0.01% MS-222 solution.

The feeding experiment was conducted for 4 weeks.

After the end of the experiment, 10 fish were randomly sampled after fasting for 24 hours and kept in a freezer at - 25°C until analysed. Then the whole body of the fish were crushed by a homogenizer and analysed.

Proximate analysis of fish meals, experimental diets and fish whole body were conducted. Methods used were Kjeldhal's for crude protein, ether extraction for crude fat, 5 hours drying at 105°C for humidity and 5 hours heating at 600°C for crude ash. Total lipid extraction of fish meal was carried out by the method of Shimma and Shimma (1970). Acid value and peroxide value were determined by the ordinary method.

Analysis of amino acid and fatty acid were carried out by the Association of Japan Frozen Food Inspection.

Details of the fish meals used in this study are presented in Table 2 and 3.

As composition of the experimental diets are shown in Table 4, approximately 46% of crude protein was provided with 20% wheat feed flour and the respective fish meal. Crude fat level was adjusted to about 10% with supplement of beef tallow. The ingredients were mixed thoroughly adding 50% of water and then formed into noodle-like solids using a meat grinder. After hot air (50°C) drying, they were crushed to the size of 2.5 mm pellet form.

RESULTS

Claro river water was used for the experiment and change of water temperature during the experiment is shown in Fig. 1. The maximum and minimum water temperature were 16.8°C and 5.2°C respectivily.

As the results of feeding experiment are presented in Table 5, fish fed diet W-1 showed the highest daily specific growth rate, feed efficiency and feed consumption. The fish fed diet B-3 resulted in the poorest daily specific growth rate and feed efficiency in all treatment.

Daily specific growth rate of fish fed diet B-1 was the second poorest result but its feed efficiency was next to that of W-1. One fish died during the experimental period in each tank of B-2 and B-3.

Whole body composition of the fish determined at the end of the experiment are presented in Table 6. The fish fed diet W-1 show the highest fat content and the lowest moisture content in all treatment. As for protein content, however, the fish fed diet B-2 exceed slightly than that of W-1.

DISCUSSION

Judging from very low humidity content (2.2%), fish meal B-2 is considered to be over- heated during a drying process. High crude fat content, 13.78% for the fish meal B-1 and 11.59% for B-2, which are about twice higher than the fish meal B-3, can be due to the difference in fat content of raw materials. Fishes in the coast of the eighth region usually contain more fat than those in the first and second region of Chile (CORFO and IFOP, 1983).

According to Toyama et al (1964), fish meal dryed by high temperature during processing usually shows poor quality and high peroxide value.

Toyama et al (1972) reported that decrease of highly unsaturated fatty acids was observed in the fish meal processed by high temperature.

Table 2. Description of Chilean fish meals used for feeding experiment.

Diet code	Type	Material	Dryer	Antioxidant (ethoxyquin)	Manufactured	
					Date	Factory
W - 1	White	Merluza	Steam	None	Sept. 1983	Nichiro, factory ship
B - 1	Brown	Horse mackerel	Flame	Added	Jan. 1984	Pesquera Landes, Talcahuano
B - 2	Brown	Horse mackerel	Flame	None	Jan. 1984	Torres y Rivera, Coronel
B - 3	Brown	Spanish sardine	Flame & Steam	Added	Oct. 1983	Pesquera Eperva, Iquique

Table 3. Results of chemical analysis of Chilean fish meals.

Diet code	Moisture	Crude protein	Crude *1 fat (A)	Crude ash	Total *2 lipid (B)	A/B	A V	P O V
W - 1	9.37	66.77	6.42	18.64	7.32	0.88	39.87	42.22
B - 1	7.23	63.30	13.78	17.41	15.34	0.90	38.98	12.32
B - 2	2.20	69.05	11.59	16.45	12.19	0.95	49.97	214.19
B - 3	6.80	71.17	6.9	16.06	11.17	0.62	65.92	43.63

*1 : Extracted by Ether.

*2 : Extracted by Methanol - chloroform.

Table 4. Percentage composition and chemical component of test diets.

Diet ingredient and nutrient content	Diet code			
	W - 1 (%)	B - 1 (%)	B - 2 (%)	B - 3 (%)
Fish meal	64.7	68.3	62.6	60.7
Wheat feed flour	20.0	20.0	20.0	20.0
Beef tallow	5.3	0.2	2.3	5.4
Vitamin mixture *1	3.0	3.0	3.0	3.0
Mineral mixture *2	2.0	2.0	2.0	2.0
C M C	5.0	5.0	5.0	5.0
Cellulose	0.0	1.5	5.1	3.9
Moisture (%)	7.1	6.3	4.9	7.6
Crude protein (%)	48.0	46.5	46.6	45.3
Crude fat (%)	11.8	10.2	9.7	10.4
Crude ash (%)	13.4	13.3	13.7	15.4

*1 : Halver 1957, one fifth of the recipt.

*2 : U.S.P. XII salt mixture N^{o} 2, with trace elements.

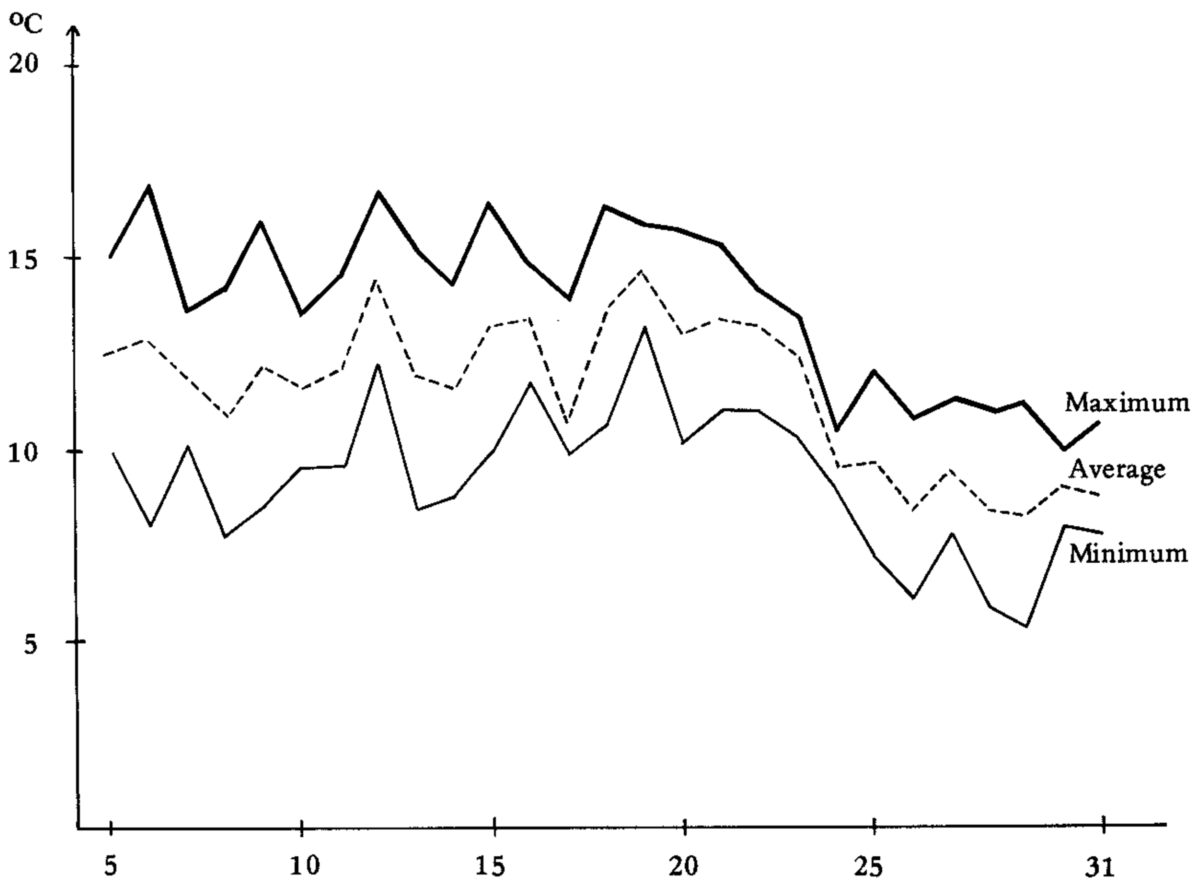

Fig. 1. Change of water temperature during.the experiment.

Table 5. Effect of dietary treatment on growth, daily specific growth rate, feed efficiency, daily feed consumption and mortality of fingerling chum salmon reared for 4 weeks.

Diet code	Initial mean weight (g)	Final mean weight (g)	Daily specific *1 growth rate (%)	Feed *2 efficiency (%)	Daily feed *3 consumption (%)	Mortality (%)
W - 1	12.29	19.67	1.74	79.69	2.15	0
B - 1	12.18	17.55	1.41	72.11	1.85	0
B - 2	12.06	18.40	1.56	67.34	2.11	3.3
B - 3	12.28	17.75	1.37	59.15	2.08	3.3

*1 : Daily specific growth rate was expressed as $(\ln Wt - \ln Wo) / t \times 100$
*2 : Feed effciency was expressed as $(Wt - Wo) / F \times 100$
*3 : Daily feed consumption was expressed as $((F/(Wo + Wt) / 2) / t) \times 100$

Wt : final mean weight F: food intake
Wo: initial mean weight t : rearing days

Table 6. Proximal analysis of the whole body of chum salmon.

	Initial	Diet code			
		W - 1	B - 1	B - 2	B - 3
Moisture (%)	76.72	78.40	78.56	79.48	80.30
Crude protein (%)	18.06	16.91	16.97	16.69	15.21
Crude fat (%)	1.95	1.99	1.54	1.44	1.62
Crude ash (%)	2.27	2.08	2.46	2.41	2.26

The results from analyses of fish meal B-2 coincide with those studies showing the high peroxide value and remarkable decrease of highly unsaturated fatty acids such as C18:3, C20:5, C22:5, C22:6 (Table 7). Shimma and Shimma (1970) indicated in their study that oxidation of lipids in fish meal is not so rapid when it is under a normal condition.

Table 7. Fatty acid composition of chilean fish meals used.

Fatty acid	W - 1	B - 1	B - 2	B - 3
C 14	3.3	4.3	7.0	5.0
C 14: 1	0.3	–	0.1	–
C 15	0.4	0.4	0.6	0.6
C 15: 1	0.1	0.1	0.1	–
C 16	18.1	20.5	29.1	20.8
C 16: 1	6.2	8.6	10.7	6.2
C 17	0.7	1.8	1.4	1.9
C 17: 1	1.1	1.3	1.4	1.0
C 18	4.2	7.0	8.9	5.9
C 18: 1	21.9	16.1	23.5	13.6
C 18: 2	2.1	2.6	1.4	5.3
C 18: 3	0.8	0.4	0.1	0.7
C 18: 4	2.3	1.7	0.3	1.7
C 20	0.1	0.2	0.3	0.2
C 20: 1	2.8	2.0	3.3	1.1
C 20: 2	0.2	–	–	–
C 20: 3	0.1	0.1	–	0.1
C 20: 5	10.2	13.9	2.2	9.6
C 22	–	0.1	–	0.1
C 22: 1	1.4	1.2	3.4	1.0
C 22: 5	1.1	2.4	0.9	1.4
C 22: 6	19.5	11.6	4.1	20.4
others	3.1	3.7	1.2	3.4

More over, storage period of the fish meal B-2 was only about 2 months after lined out.

According to Nose and Toyama (1966), it is noticed that there is appreciable difference between ether and methanol - chloroform in their ability to extract fat from fish meal in relation to protein digestibility. The fish meals used in this experiment also present difference of those extracts as shown Table 3.

As seen in ratio of ether / methanol - chloroform extract, fish meal B-3 shows exceptionaly low ratio but others show similar ratio.

Acid value of fish meal B-3 is 65.92, which is highest among them. On the other hand, its peroxide value (43.63) is not so high. It is known that peroxide value decreases once reached the peak level. Whether this peroxide value is still rising or declining is not certain in this study. However, no significant difference in composition of highly unsaturated fatty acids between the fish meal B-3 and B-1 was observed.

As for amino acid composition shown in Table 8, there was no notable difference among all fish meals, so that comparison by amino acid composition for quality evaluation in this study and E A A Index was not effective.

Table 8. Amino acid composition of the chilean fish meals used.

Amino acid	W - 1	B - 1	B - 2	B - 3
	%	%	%	%
Isoleucine	3.02	2.65	3.17	3.03
Leucine	5.30	4.95	5.51	5.38
Lysine	5.67	5.24	5.92	5.66
Methionine	2.13	1.82	2.11	2.05
Cystine	0.69	0.64	0.68	0.60
Phenylalanine	2.70	2.50	2.81	2.75
Tyrosine	2.32	2.08	2.21	2.20
Threonine	3.12	2.91	3.22	3.09
Tryptophan	0.62	0.69	0.70	0.73
Valine	3.44	3.28	3.77	3.72
Arginine	4.38	3.85	4.31	4.26
Histidine	1.43	2.49	2.64	2.21
Alanine	4.25	4.20	4.60	4.61
Aspartic acid	6.58	6.13	6.79	6.49
Glutamic acid	9.61	8.12	9.32	8.91
Glycine	4.40	4.19	4.34	4.93
Proline	3.45	2.92	3.12	3.40
Serine	3.23	2.87	2.98	3.15
E A A I	55.39%	54.69%	60.39%	58.69%

The result of whole body analyses shown in Table 6 revealed that protein and fat contents in all groups were lower than those of study by Akiyama et al (1983, 1984). Especially fat levels were very low (1.44 - 1.62) in the fish fed brown fish meal diets which were adjusted to about 10% by supplementing with beef tallow. The lowest fat level observed in the fish fed diet B-2 was similar to that of fish fasted for 2 weeks after being fed the diet containing 5.1% fat (Akiyama et al, 1984). Takeuchi et al (1978) reported that fish fed diet supplemented with only animal fat, such as lard and tallow, showed poor growth and feed convertion but if animal fat was enforced with other lipids such as cod liver oil providing the necessary level of essential fatty acids, rainbow trout achieved normal growth.

Lipid utilization of chum salmon fry is quite different from that of rainbow trout, as reported by Akiyama et al (1980), chum salmon has less ability of accumulating body fat than rainbow trout and optimum level of dietary fat for chum salmon is considered to be about 10% against to 15 - 20% for rainbow trout (Akiyama, et al 1981, Takeuchi, et al 1978).

It is reported that high temperature in drying process deteriorate digestibility of fish meal (Tanigawa 1960). Nose and Toyama (1966) concluded that the lowering of protein digestibility depends mainly on the drying process, in which reactions between protein and oxidized oil may proceed.

From these results, it can be concluded that the chilean brown fish meals used in this experiment, except B-1, are not recommended as a protein source for fingerling chum salmon.

Further study is needed on the protein digestibility of fingerling chum salmon.

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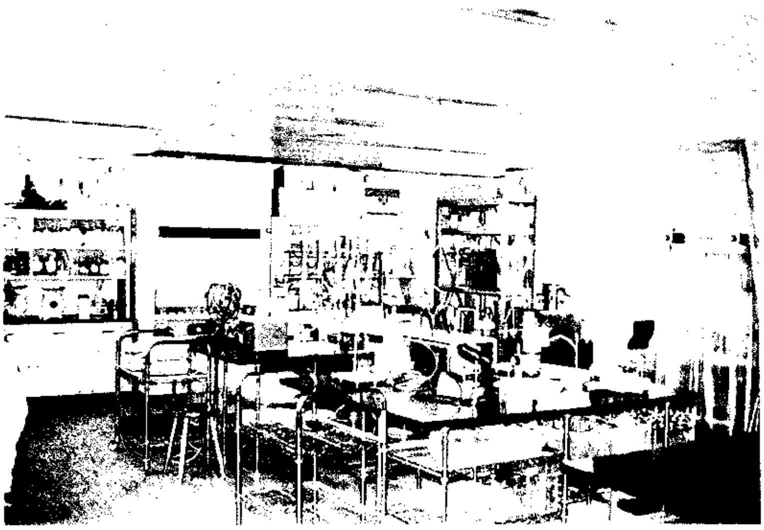

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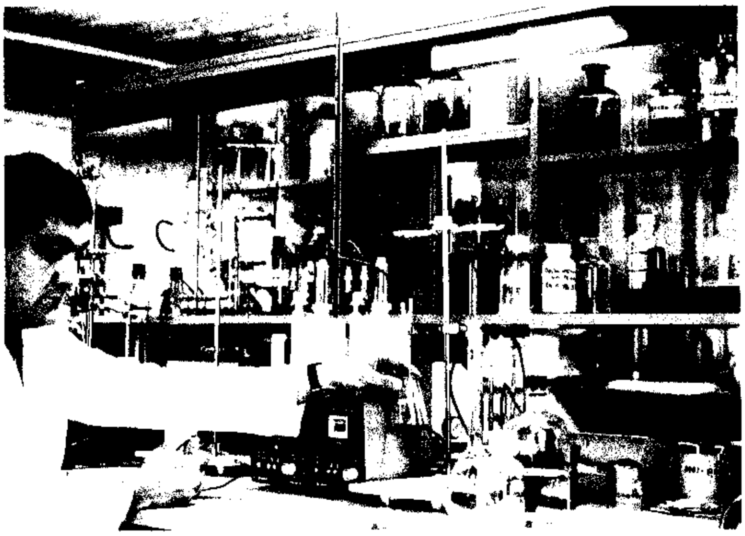

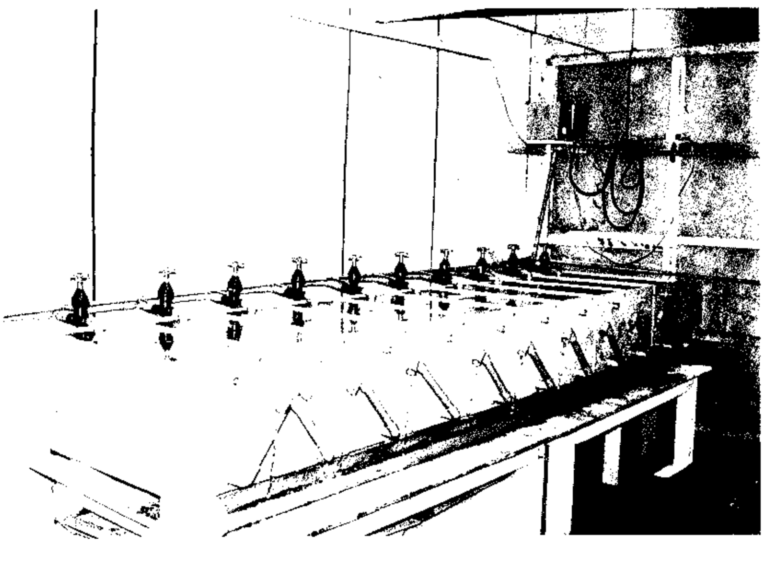

◁ Feeding Experiment
Aquariums