


# AQUACULTURE NOTE

A line drawing of a salmon swimming in water, with seaweed and bubbles around it. The drawing is simple and stylized, using only outlines.

## The Value of Krill Meal in Salmon Starter Diets

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and M.S. Kelley



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## Abstract

In an indoor experiment, chum salmon fry (*Onchorynchus keta*) were fed a commercial starter diet, pure krill meal, or mixtures of the two (25%-75%, 50%-50%, and 75%-25%) for 10 weeks. Rearing was in seawater at a temperature of 6°C. Fish fed diets containing 25%, 50%, and 75% krill showed significantly better growth, feed efficiency, and survival than fish fed diets containing no krill or only krill. It was concluded that krill meal can be a good partial substitute of fish meal-based commercial diets. Furthermore, krill meal seemed to enhance feeding activity.

## Introduction

Alaska fish hatcheries release hundreds of millions of pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) fry every year (FRED 1988). Pink and chum salmon differ from other Pacific salmon species, such as coho (*O. kisutch*) and chinook (*O. tshawytscha*), in that the fry can be released in saltwater immediately upon yolk sac resorption. However, short-term feeding for one or two months, coupled with a release that coincides with high estuarine zooplankton concentrations, increases early marine survival and adult returns (Martin et al. 1981).

Commercial diets currently in use for pink and chum salmon fry can vary substantially in quality from year to year (Ladd E. Macaulay, personal communication, 1988). They were developed for salmonid rearing under the moderate water temperature conditions found in Washington and Oregon, rather than for Alaska conditions. Tests on chum salmon by Kron (1985) showed that a diet formulation with herring meal, marine fish oil, and blood meal as main ingredients (Alaska Dry Pellet, Icicle Seafoods, Inc., Seward, Alaska) was more efficient under Alaska conditions than commercial rations. Kerns (1985) conducted an extensive study of pink and chum diet development in Alaska. He found fresh pollock roe or diets based on cod roe to be equally good or superior in terms of growth, survival, and returns when compared to commercial diets.

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**Table 1. Proximate analysis of krill meal.**

Ingredients	Percent
Moisture	5.6
Protein	54.5
Fat	15.1
Ash	15.3
Chitin	4.4
Carotenes	20.8 (mg/kg)

It may be necessary to stimulate chitinase activity in salmon fry that are to be released. Feedstuffs containing chitin may be effective in that respect.

Research should be continued to evaluate good sources of chitin and lipids using existing and possible new Alaska fisheries by-products in order to improve pink and chum salmon starter diets. One potential dietary source of the future is krill. Estimates are that over 300 million metric tons of krill (equal to three times the current, total fish harvest of the world) could be harvested annually, with a good share coming from Alaska waters (Spinelli 1980).

Krill is a good source of chitin and lipids (Table 1). It contains flesh coloring pigments, highly desirable in salmon culture (Spinelli 1979), and protein from krill is high in nutritional value (Storebakken 1988). Krill could replace fish meal as the main ingredient of fish feeds (Koops et al. 1979). This option is significant because demands for fish meal are increasing while resources may become limited.

## **Materials and Methods**

Post-larval chum salmon, averaging 0.41 g, were stocked in 15 rearing units at a density of 150 fry per unit. Fish came from a local Juneau stock. Rearing units consisted of small, rectangular, plastic garbage cans

(1 x h x w = 33 x 33 x 18 cm) with 25 x 25 cm areas cut out of each side. The cut-out areas were replaced with screening to allow water to circulate through the rearing units. The units were suspended in larger saltwater rearing tanks. The smaller rearing units were cleaned daily and larger tanks were cleaned weekly. Water temperature averaged 6°C. Water flow was in excess of 4 liters per minute in the rearing units. Photoperiod was that of Juneau latitude in April-May. Oxygen levels were not routinely measured, but were normally above 5 ppm. Fish density at the start of the study was 4 kg per cubic meter.

Five different diet combinations were tested in the rearing units. Diets were mixtures of BioDiet Starter (Bioproducts Inc., Warrenton, Oregon) and krill (*Euphausia superba*) meal powder (Murex Aqua Foods Inc., Langley, B.C., Canada) in the following ratios: 100%-0%, 75%-25%, 50%-50%, 25%-75%, 0%-100%. Table 1 gives the proximate analysis of krill meal powder.

Feeding rate was 3% body weight per day and feeding frequency was 4 times per day, except on weekends when feeding was once a day at only 1.5% body weight. Every two weeks, fish were weighed as a group for feed allowance adjustments. Main parameters monitored were weight gain, feed conversion efficiency (FCE = wet weight fish gain per amount feed fed), and mortality. Statistical tests used were analysis of variance and Scheffe's multiple range test ( $p < 0.05$ ), using SAS on the University of Alaska Fairbanks' mainframe, to distinguish statistically significant differences among diet groups (SAS 1985).

## Results and Discussion

At all sampling times, fish fed the 25%, 50%, and 75% krill diets experienced greater weight gains than fish fed the 0% krill diet (Figure 1). Fish fed the 100% krill diet initially had good weight gains, but started to experience high mortality later on, presumably due to vitamin deficiencies. During high-temperature drying of krill meal, many naturally occurring vitamins are lost. Fish fed the 0% krill diet experi-

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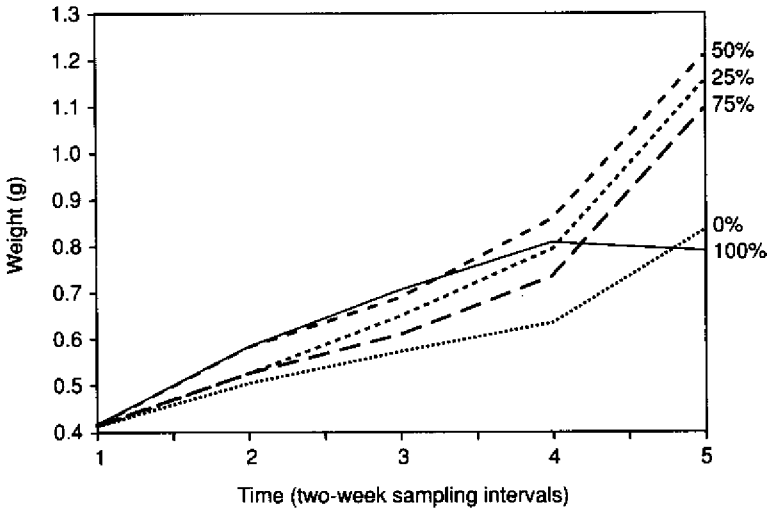


Figure 1. Chum salmon growth study: The effects of krill as dietary feedstuff in % krill.

enced two periods of very low water flow. The first period resulted in high mortalities, and, therefore, two rearing units were combined into one. After the second period of low water flow, no mortality occurred, but the fish were definitely stressed. As a result, mortality of fish fed the 0% krill diet was higher than expected.

After 10 weeks, fish fed diets with 25%, 50%, and 75% krill showed significantly better weight gain, feed conversion efficiency, and survival than fish fed 0% and 100% krill diets (Table 2). It was expected that the fish fed only krill would suffer vitamin deficiencies, but the fish fed no krill (thus only commercial diet) also performed poorly, explainable only in part by the two periods of low water flow.

The feeding response of fish fed the intermediate krill diets was immediate and aggressive relative to the fish fed the 0% and 100% krill diets. Fish response was assessed by visual observations of time to onset of

**Table 2. Initial and final mean weights, weight gain, feed conversion efficiency, and mortality of chum salmon fry fed diets varying in krill meal content for 10 weeks.**

Percent krill	Initial mean weight (g)	Final mean weight (g)	Weight gain %	FCE	Mortality %
0	0.41	0.83*	202*	-0.10*	29*
25	0.41	1.15	280	0.40	4.9
50	0.41	1.21	295	0.43	2.4
75	0.41	1.09	266	0.60	2.9
100	0.41	0.79*	193*	-1.83*	74*

\*Significantly different from other values in column ( $p < 0.05$ ).

feeding and number of fish breaking the water surface.

It was our conclusion, therefore, that the addition of krill meal was beneficial for chum salmon fry as a high-quality substitute for the fish-meal-based commercial diet. Feeds of 25%, 50%, and 75% krill performed equally well and seemed to serve as a feeding attractant as well. Further research should emphasize the manufacture and testing of krill-based starter diets. Additional studies into the feasibility of krill fisheries and harvesting in Alaska may also be desirable.

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