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FISH OILS AS A SOURCE OF PIGMENTS IN TROUT AND SALMON FEEDS

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Abstract

Fish oils produced by the reduction of fish which have been feeding heavily on planktonic organisms ("red feed") often have a distinct red color caused by carotenoid pigments. Pigments of this type must be added to the feed of farmed trout and salmon in order to attain the attractive pink flesh coloration found in wild fish. "Red fish oils" could therefore be used instead of regular fish oils in fish feeds in order to satisfy at least a part of the pigment requirements. Several hundred tons of red capelin oil were sold to fish farmers in Norway in 1974. Preliminary analyses of Canadian Atlantic Coast herring oils indicate that some of these oils could also be used for this purpose and processors should have "red oils" analyzed for carotenoid content when available. Oil from redfish (Ocean Perch) has a low content of carotenoid pigments.

Introduction

In order to duplicate the attractive pink coloration found in the flesh of wild salmonids, reared trout and salmon must have pigments added to the feed. The color is usually due to the carotenoid pigment astaxanthin, which is commonly found in a number of crustaceans. Shrimp waste, either fresh, frozen or dried, has been extensively used as a feed ingredient for

pigmentation purposes. A synthetically produced carotenoid, canthaxanthin, which is closely related chemically to astaxanthin, is also commonly used. In recent years moderate quantities of the copepod "red feed" (Calanus sp.) and krill (Euphausiids) have been used in Norwegian fish farms.

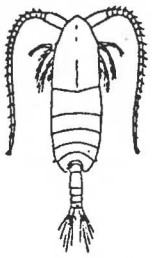
> It would perhaps be of interest to mention here that there is no connection between "red feed" and "red tide". "Red feed" refers to the bright red stomach contents of fish (herring, mackerel, etc.) feeding heavily on concentrations of zooplankton, especially Calanus species. The best known of these is Calanus finmarchichus, which reaches a length of 3-4 mm. "Red tide" is usually caused by a microscopic one-celled organism (a so-called dinoflagellate) identified as Gonyaulax tamarensis. This organism contains a toxin that does not kill the shellfish that feed on it, but it does poison the warm-blooded animals, including man, that eat the shellfish. When a Gonyaulax population builds up suddenly in what biologists call a "bloom", the masses of the organism give the water a rusty color, hence the term, "red tide".

Recent Information from Norway

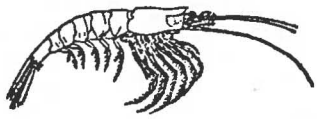
In the 1974 annual report of the Norwegian sales and export organization Norsildmel A/L, it was stated that 408 metric tons of "red oil" had been sold to fish farms in that year. The use of carotenoid-containing fish oils for fish feed would appear to have some obvious advantages since fish oils are already commonly used as a source of energy in commercial fish feeds. However, very few fish oils contain sufficient quantities of carotenoids to have any significant effect on flesh pigmentation. The best source would be oil rendered from fish that had been feeding heavily on carotenoid-containing zooplankton.

The source of the Norwegian "red oil" sold to fish farms is capelin oil from the summer fishery in the Barents Sea. This ocean fishery is of fairly recent origin and scientists and processors soon noticed that the oil was quite different from regular winter capelin oil. In addition to

the pink or red color, the unsaponifiable matter was in some cases very high (up to 10%). This is similar to the oil from the most important food organism of the capelin, Calanus sp., which contains wax esters.



A "red feed" organism
(the copepod Calanus finmarchichus
(3-4 mm))



A krill (the euphausiid
Meganyctiphanes norvegica
(up to 40 mm))

A number of samples of red oils, shrimp waste, etc., were analyzed for astaxanthin by Lambertsen and Braekkan (1971) with the following results:

	Astaxanthin Micrograms/gram Wet weight		Astaxanthin Microgram/gram Wet weight
Krill, Sample 1	77.4	Capelin oil, Sample 3	6.6
Krill, Sample 2	22.4	Capelin oil, Sample 4	5.7
Calanus (red feed)	46.5	Mackerel oil, Sample 1	11.3
Lobster shells, boiled	35.3	Mackerel oil, Sample 2	6.3
Shrimp waste, boiled	66.0	Ocean perch oil	0.8
Krill oil	727	Industrial Norwegian shrimp meals	0- 8.9
Calanus oil	520	"Foreign" shrimp meals	12.8-24.5
Capelin oil, Sample 1	94.3	Vacuum dried shrimp meal	76.2
Capelin oil, Sample 2	39.5		

It can be seen from this table that some capelin oils compared favorably with shrimp waste, krill and Calanus as a source of astaxanthin, while the oil extracted from krill and Calanus is, of course, very high. The very low content in redfish (ocean perch) oil and the rather high content in lobster shells should be noted.

A recent report (Ugletveit, 1974) describes feeding trials carried out in Norway with red capelin oil and other feed ingredients in order to determine their relative effects on flesh pigmentation in farmed rainbow trout in seawater.

The astaxanthin contents of the pigment sources tested were as follows:

Pigment source	Astaxanthin Micrograms/grams
Shrimp waste (cooked)	121.1
Red feed	72.6
Krill	77.8
Capelin oil	71.2

The composition of the various diets used in the experiments were as follows:

	Percent by weight							
	1	2	3	4	5	6	7	8
Pollock fillet cuttings	92.18	92.18	92.18	92.18	92.18	87.91	86.65	85.19
Mackerel oil	7.02	7.02	7.02	7.02	--	7.16	7.12	7.12
Binder	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Capelin oil	--	--	--	--	7.02	--	--	--
Shrimp waste	--	--	--	--	--	4.13	--	--
Krill	--	--	--	--	--	--	6.43	--
Red feed (Calanus)	--	--	--	--	--	--	--	6.89
Citranaxanthin (pure)	--	0.0005	0.0010	--	--	--	--	--
Canthaxanthin (pure)	--	--	--	0.0005	--	--	--	--

The pigment citranaxanthin which was included in the feeding trials occurs in citrus fruits and has been used in chicken feed to pigment the egg yolk. Both citranaxanthin and canthaxanthin are deposited in the yolk, but only canthaxanthin will pigment the skin of the chicken.

The experimental fish were rainbow trout with an average weight of 150 grams. They were kept in floating pens in seawater with a salinity of ca. 20 °/₀₀ and a temperature of ca. 8°C. Each pen contained 800 trout at the start of the experiment.

The results were not conclusive since the fish were maturing and carotenoid levels in the flesh tended to level off after about 8 weeks. When fish are maturing, carotenoids are also deposited in the developing gonads. However, it was established that the astaxanthin in capelin oil was absorbed and deposited in the flesh at least as well as the astaxanthin in shrimp waste. Canthaxanthin also was deposited in the flesh, but citranaxanthin was not.

Canadian Studies

Orange to red colored herring oils have occasionally been produced in reduction plants in Newfoundland in the spring and the Gulf of St. Lawrence in the summer. However, all of this oil is sold for human consumption and the pigments are removed in the refining step. Oil from redfish (ocean perch) is also produced in considerable quantities in Eastern Canada, but Lambertsen and Braekkan's analytical results indicate that the red color of this oil is not due to free or fatty acid esterified astaxanthin. It is therefore doubtful that this oil will have any effect on flesh pigmentation in salmonids.

A few preliminary analyses have been carried out on two Canadian red herring oils and a carotenoid level of about 10 micrograms/gram was found. Since these oils were not selected because of their red color and since they had been in storage for two years, it is reasonable to assume that much higher levels could occur. The quality control procedure of oil at the plant level should therefore include red color in order to separate lots with high contents of carotenoids.

Feeding experiments were carried out at the Halifax Laboratory in order to compare the pigmentation effect of snow (Queen) crab waste, shrimp waste

and canthaxanthin on the flesh of brook trout in fresh water. The shrimp and crab shells were vacuum dried and contained 100 and 4.7 micrograms astaxanthin, respectively, per gram dry weight. As could be expected from these values, the dried crab waste had very little effect on the color of trout flesh while both shrimp waste and canthaxanthin were very effective (Saito and Regier, 1971).

Additional Reading

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