Farmed Fish & Omega-3 Fatty Acids

Fish Feeds & Nutrition

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Good luck finding a popular magazine or newspaper that has not contained an article on farmed fish lately. The articles all have a similar slant, namely that fish farming is bad for the environment and that consumers are mistaken if they think that they are doing themselves any favors by eating farmed fish because farmed fish are vastly inferior to their wild counterparts in nutritional value. What these articles tell me is that the writers need to review grade school mathematics, especially the part where percentages are covered, because the data that appears in many of the articles actually contradicts the claims of the writers that eating wild fish increases one's omega-3 fatty acid intake compared to eating an equivalent portion of the same species that was grown in a fish farm. We read that the educational system in the USA does not teach people to think critically or solve simple problems. Judging from these articles, there is a lot of truth in this assertion, apparently especially so for journalism majors.

My example is an article that appeared in the January 27, 2003, issue of BusinessWeek. (Note: I saw similar articles in Newsweek, the LA Times, the Seattle Times, Men's Health, and even the Twin Falls Times-News, my local paper!) BusinessWeek is a highly regarded magazine that generally gets things right. It contains a section called BusinessWeek Investor that is a dozen or more short features and sidebars, often dealing with lifestyle issues like new beers and wines, interesting cars, various new consumer goods, and brief health and nutrition blurbs. The title of the article was "When it comes to fish, go wild." The headline said "The free-range varieties are better for you than their farm-bred cousins." There is not much room for doubt in these assertions. The article begins with a short statement of why many people eat fish, such as it has less fat than other kinds of meat and they think that it contains "good fat," meaning omega-3 fatty acids, and these compounds are known to reduce disease of the circulatory system, help with depression, and maybe even help prevent Alzheimer's Disease. However, the author then goes after farmed fish, saying that they contain more fat than wild fish and the ratio of omega-3 fatty acids to saturated fats is much lower because farmed fish are fed fish meal, corn and soy pellets, whereas wild fish hunt their own food and are therefore leaner and taste better. Lucky for us alert readers that the article also contains a table with USDA-derived data, because if we look at the data in the table and exercise a few brain cells, low and behold, we realize that the article gets it all wrong. The table from BusinessWeek is reproduced here as Table 1.

The USDA data shows that in all four examples, the farmed fish contains more fat and a lower percentage of omega-3 fatty acids than the wild fish. However, consumers do not eat percentages, they eat grams per serving. The flaw in the interpretation in BusinessWeek and other places where the same information appeared is that farmed and wild fish were not compared on a gram omega-3 per serving basis, but on a percentage omega-3 fatty acid in the fat basis. This does not take into account differences in fat level between farmed and wild fish; one must convert percentage omega-3 fatty acid in the fat to percentage or grams of omega-3 fatty acids per serving. This is not high mathematics. To make the conversion, one must simply multiply the fat content of the portion of fish by the percentage of omega-3 fatty acids in the fat. I have done so in Table 2. The good news is that consumers actually receive slightly more grams of omega-3 fatty acids by eating a portion of farmed Atlantic salmon and farmed trout than by eating the same portion of wild fish, and only 0.1 g less of omega-3 fatty acids by eating farmed coho salmon or catfish than by eating wild fish. Order is restored to the universe and all is well for the consumer.

All is not well, however, for the aquaculture industry. The fact that writers are attacking farmed fish on the basis of omega-3 fatty acid content and healthfulness to the consumer is something new and it should give fish nutritionists pause, even if the critics are bad at math. Aquaculture is about to have a big problem in this area, namely the annual global production of fish oil, the main source of omega-3 fatty acids in the diets of farmed fish, will be tapped out in the relatively near future. As I wrote in this column in the July/August 2001 issue, annual production varies from year to year but

averages about 1,300,000 to 1,400,000 metric tons. Estimates of the percentage of this annual total that is used in fish diets is about 75%, up from less than 12% before 1990. Back then, most fish oil was hydrogenated and made into margarine but concerns about eating hydrogenated oils (trans fatty acids) and the willingness of the fish feed industry to pay higher prices for fish oil changed use patterns. Omega-3 fatty acids are essential dietary nutrients to fish; marine and anadromous species need about 1% in their diets whereas freshwater species need less. Plant oils contain small amounts of omega-3 fatty acids (an exception is linseed oil which contains 55% 18:3, or linolenic acid), and fish meal also supplies some omega-3 fatty acids by virtue of residual oil (about 6-8% total oil, of which about 1% is omega-3). It is well known that plant oils and animal fats can be used in fish feeds to supply dietary energy and, as long as the diet contains at least 1-2% omega-3 fatty acids, fish grow normally and suffer no deficiency signs. Some marine species, such as sea bream, sea bass, and probably most other marine carnivores, need higher amounts of omega-3 fatty acids in their diets when they spawn, but for fish being grown for market, almost any lipid source will do.

The fatty acid content of fish tissues reflects the fatty acid content of their diet, and this metabolic reality presents difficulties for the aquaculture industry when plant and animal lipid sources replace fish oil in the diets of farmed fish. If trout, for example, are fed diets containing soybean oil, the fatty acid profile of their tissues resembles soybean oil more than fish oil, having elevated levels of linoleic acid (C18:2, omega-6). Similarly, when poultry fat is fed, the fatty acids in tissues shift to higher amounts of oleic acid (C18:1). Because fish must maintain certain fatty acid profiles in membranes and tissues to sustain life, the shifts in profiles associated with intake of various lipids are not so much as to make the fish fatty acids nearly identical to the dietary lipid source. For example, the saturated fatty acid content of trout or salmon tissues can be modified, but only within a relatively small range. The omega-3 fatty acid content can also be modified, but again only within a range. Fish possess the ability to modify dietary fatty acids by elongation, desaturation, and other metabolic mechanisms. As I mentioned in an earlier column, researchers need to study the dynamics of fatty acid modification, deposition and turnover in muscle tissue of fish, and develop phase-feeding strategies to ensure that farmed fish products continue to be excellent sources of omega-3 fatty acids.

Should we perhaps have target levels of omega-3 fatty acids in farmed fish? If we base such targets on levels in wild fish, we may have a problem because wild fish differ greatly in total fat and omega-3 fatty acid level within species. For example, although the average fat content of wild coho salmon is 5.7%, the range is 3.1% to 9.0%, depending upon the stock of fish, when and where it was caught, and even what part of the fish fillet was sampled (Table 3). The same is true for chinook salmon and most likely other wild fish. Food abundance in nature varies from year to year, season to season, and from location to location, and this affects the total fat level of fish tissues. One must remember that the values found in the USDA Nutrient Database are average values, not absolute amounts. One could sample a few wild fish and most likely find values for total fat level and percentage of omega-3 fatty acids in muscle tissue that differ from USDA values. However, USDA values are useful because they are averages of thousands of samples taken over multiple years, and thus are the most accurate values to be found. I recommend that we use the USDA values as our target levels, remembering to express omega-3 fatty acid levels on a gram per serving basis so as not to confuse the journalists of the world.

The Monterey Bay Aquarium's Seafood Watch Program recently revised their rating of farmed rainbow trout, moving it from "proceed with caution" to "Best Choice," based on information provided by the U.S. Trout Farmers Association, the University of Idaho, and others. Their web site (http://www.mbayaq.org/cr/seafoodwatch.asp) now offers the following: "Several species of trout inhabit freshwater streams in Europe and North America. The rainbow trout, native only to western North America, is now widely farm-raised. All trout you'll find in U.S. markets is farmed raised, mainly from the states of Idaho and North Carolina. U.S. trout farms are regulated and monitored by the EPA and state water quality departments. Though there has been concern that farmed trout could spread diseases to wild trout populations, research shows that disease outbreaks and their effect on wild populations are minimal. Although trout are carnivorous fish, they are efficient at converting their feed into edible protein. To reduce their impact on wild fisheries, trout farmers are reducing the amount of fishmeal in trout feed. Therefore, we can recommend trout as a "Best Choice." Congratulations to the Monterey Bay Aquarium for looking into the facts and revising their position on farmed rainbow trout!

References

Hardy, R. W. and I. B. King. 1989. Variation in n-3 fatty acid content of fresh and frozen salmon. Omega 3 News, IV(4): 1-4.

Murphy, K. "When it comes to fish, go wild." BusinessWeek, January 27, 2003, p. 116.

Table 1. Fat content, percent total fat as omega-3 fatty acids, and total calories of selected farmed and wild fish (from January 27, 2003 BusinessWeek, p. 116). Values are based on a 100 g serving, ca. 3.5 ounces. Data from USDA Nutrient database.

Fish	Fat per serving	Omega-3s (% of fat)	Total calories
Wild Atlantic salmon	6.34	27%	142
Farmed Atlantic salmon	10.85	17%	183
Wild coho salmon	5.93	22%	146
Farmed coho salmon	7.67	16%	160
Wild trout	3.46	20%	119
Farmed trout	5.40	17%	138
Wild catfish	2.82	19%	95
Farmed catfish	7.59	5%	135

Table 2. Grams of omega-3 fatty acids per 100 g serving of selected wild and farmed fish. Data from USDA Nutrient database.

Fish	Fat per serving	Omega-3 (% of fat)	grams omega-3/serving
Wild Atlantic salmon	6.34	27%	1.7
Farmed Atlantic salmon	10.85	17%	1.8
Wild coho salmon	5.93	22%	1.3
Farmed coho salmon	7.67	16%	1.2
Wild trout	3.46	20%	0.7
Farmed trout	5.40	17%	0.9
Wild catfish	2.82	19%	0.5
Farmed catfish	7.59	5%	0.4

Table 3. Lipid content and omega-3 fatty acid content of salmon (% wet weight).

Fish	Mean ± SEM	Range	Omega-3 content	
			Mean	Range
Chinook salmon	11.5 ± 2.4	2.2-19.0	1.8	0.5-3.0
Sockeye salmon	7.5 ± 1.2	1.6-19.2	1.1	0.3-2.9
Coho salmon	5.7 ± 0.5	3.1-9.0	1.2	0.6-1.8
Pink salmon	5.3 ± 0.4	2.0-9.4	1.7	0.6-3.1
Chum salmon	4.3 ± 0.6	1.3-4.8	0.8	0.3-0.9
Atlantic salmon	11.0 ± 1.1	8.7-14.0	3.5	2.3-4.4

From Hardy and King, 1989