

Fish – made of soya?

Continuing our series on the effects on our diets of modern farming we look at fish – and ask whether the feed given to farmed fish reduces their value to human health. Tim Lobstein reports.

Throughout the 1980s and 1990s, increasing evidence showed the value of fish oils to human health. Scientific papers showed the benefit of these oils in preventing heart disease and providing various other benefits including a reduced risk of mental problems such as bipolar disorder and senile dementia. The US Food and Drug Administration has ruled that foods containing these oils can carry a health claim that they can help to reduce the risk of heart disease.

As a result of this accumulating evidence, committees of experts have recommended that minimum quantities of these oils should be included in our diets on a regular basis. The 'Eurodiet' consensus suggested an average intake of 200mg per day of the very long chain omega-3 polyunsaturated fatty acids – the fats found in plankton and other minute aquatic organisms, and in the fish and other creatures that eat them. Depending on which fish species you choose, the consensus is that we should eat at least 140g (5 oz) of oily fish per week.

Fish stocks are unlikely to be able to sustain this quantity of fish for the whole human race unless they are more carefully managed, and unless protection of spawning grounds and other measures to preserve fish stocks are enforced. In the meantime, fish farming has developed rapidly and world

aquaculture output has risen around 10% per year for the last two decades. Fish farms are supplying increasing quantities of the world's fish market – UK fish farmers reared over 150,000 tonnes of salmon and trout in 2002, as well as increasing quantities of species such as turbot, halibut and char.

The rise in farmed fish production has significant environmental consequences: the fish cages create pollution, and the fish have to be dosed with pesticides and antibiotics to prevent infestation and disease. The flesh of the fish tends to be pale and grey compared with wild stock, so colouring agents may be added to the fish feed.

And, as with the diets of intensive broiler chickens, farmed fish are usually fed a concentrated diet designed to maximise weight gain in as short a time as possible. In intensive farms, fish are not encouraged to swim extensively as this slows down weight gain. Fish feed is given in pellets which float and which are carefully sized to be 25% of the size of their mouths to ensure they eat as



"And for dessert may I recommend the Super Soya Surprise!"

much as possible and spend as little time as possible finding the pellets.

The effect of this imposed lifestyle is to make flesh fatty but the nature of that fat depends on the content of the fish feed. With world fish stocks threatened by over-fishing and by global warming, fishmeal is becoming harder to obtain. Marine oils especially have been rising in price and exceeded the price of vegetable oils such as soya oil in the late 1990s.

The result is that many fish farmers have been substituting vegetable oils for marine oil in fish diets. In their early, larval stages, fish need high levels of omega-3 type fatty acids, but as they grow into fry and later maturity they can survive on the blend of omega-3 and omega-6 oils found in vegetable oils. But this will affect the oils in their flesh, and that in turn could affect our dietary health.

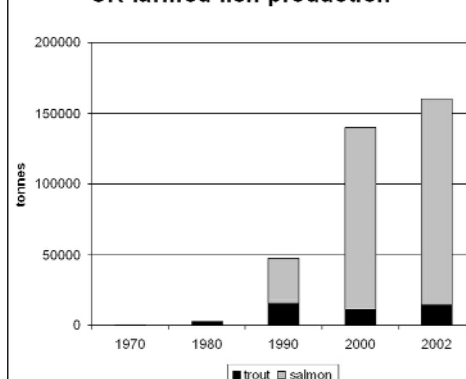
For humans, the quantity of long-chain omega-3 fatty acids is important, but so too is

Table 1: Farmed fish have more oil, but a poorer ratio of omega-3 to omega-6 fatty acids

	Coho Salmon		Atlantic Salmon		Catfish		Trout	
	Farmed	Wild	Farmed	Wild	Farmed	Wild	Farmed	Wild
Total oil	7.67g	5.93g	10.85g	6.34g	7.59g	2.82g	5.40g	3.46g
Total omega-3	1.28g	1.24g	2.01g	1.73g	0.37g	0.81g	0.99g	0.71g
Total omega-6	0.44g	0.33g	1.78g	0.43g	0.96g	0.25g	0.74g	0.35g
Ratio of 3 to 6 (the higher the better)	2.9	3.8	1.1	4.0	0.4	3.2	1.3	2.0

Source: Purdue University, <http://fn.cfs.purdue.edu/anglingindiana> Amount per 100g fish.

UK farmed fish production



the ratio of omega-3 to omega-6 fatty acids in the diet. Omega-6 fatty acids compete with omega-3s, and an excess of omega-6s will reduce the effectiveness of eating omega-3s.

The Eurodiet consensus recommended that our dietary intake of fats would be balanced if we ate up to around 15g omega-6 and 2.2g of omega-3 (including 0.2g long chain omega-3s). The latest survey of UK diets shows that on average, adults are eating around 11g of omega-6 and less than 2g of omega-3. More than half the population is failing to eat the recommended minimum amount of oily fish (one portion per week).

Wild fish, such as herring, have very little omega-6 – typically 2% of their oils are omega-6 fatty acids, and 15% to 30% of the oils are omega-3 fatty acids, much of this in the form of the valuable long chain omega-3s. Fresh water fish, such as trout, have more omega-6, but still substantially less omega-6 than omega-3.

But with farmed fish the situation changes, and is destined to change far more. As table 1 shows, the ratios of omega-3 to omega-6 are worse in farmed fish. And as table 2 shows, feeding trout with an experimental mixture of feed containing higher levels of soya oil led to a dramatic increase in the omega-6 content of the fish, and a matching decrease in the omega-3s.

In the name of sustainable production, groups such as the World Wide Fund for Nature (WWF) are calling for increased use of vegetable oils in fish farm production. But little research has been done on the nutritional effect of different types of vegetable oil in fish diets. Soya, the cheapest oil, has a high omega-6 content as does sunflower and corn oil (see table 3), although other oils, such as linseed, have a much higher omega-3 content. These are currently more costly to fish farmers, partly because they have not received the investment and development

Table 3: Omega-3 and omega-6 fatty acids in cheaper vegetable oils (% of the oil)

	palm oil	soya oil	corn oil	sunflower oil	cottonseed oil	rapeseed oil
Total omega-3	0.2	6.8	1.2	0.03	0.2	9.3
Total omega-6	9.1	51.0	53.2	65.7	51.5	20.3
ratio of 3 to 6 (the higher the better)	0.02	0.13	0.02	0.001	0.04	0.46

Source: USDA <http://www.nal.usda.gov/fnic/foodcomp/>

which have benefited soya producers. And although fish can convert the omega-3 oils in vegetable oil into the beneficial long chain omega-3s that we expect to find in fish, the rate of conversion is slow and unreliable.

Genetic selection of fish breeds capable of converting vegetable oils into long chain omega-3 oils is considered feasible, and genetic modification of plants may increase their omega-3 content – but these approaches may not be popular with the public.

A more positive approach may be taken by revisiting the food chain that makes fish so valuable. Single cell organisms (marine algae) and more complex plankton capable of producing long chain omega-3 oils are the primary building blocks in the fish food chain. Such marine organisms are already being harvested for the food supplement market and their industrial culture could be the basis of marine fish feed – but again the system requires considerable investment.

Meanwhile, programmes to ensure sustainable harvests from the sea, protected breeding grounds, strongly enforced controls on net mesh sizes and the prohibition of trawling methods which damage the sea bed are necessary to ensure a vital nutritional resource remains available for as long as possible.

The end of the line?

Don't expect a comfortable read with this book, particularly if you enjoy a trip to a sushi bar or a fresh fish feast on your holiday in the Med. From page one, Charles Clover, Environmental Editor for the *Daily Telegraph*, sets out to present the truth about the demise of the world's fish stocks and the destruction of many marine environments.

The main culprits behind this disaster in the making, Clover believes, are unworkable fishing policies and governments refusing to take action over a fishing industry too large and too greedy to enable sustainable fishing in all but a few areas of the world's oceans.

Clover presents some alarming facts, such as 50% of cod and 60% of hake are illegally landed on our shores, making a mockery of any quotas set for sustainability. He paints a grim picture of the state of today's fishing industry: fishing pirates, poor countries unwittingly selling off their fishing legacies, unimaginable levels of discarded fish and marine mammal by-catch and near-barren seas where fish stocks have completely collapsed. A few glimmers of hope are offered with some individual programmes that have revived the local marine environment.

A shopper's guide to choosing fish is given at the end of the book. It is rather more restrictive than that presented by the Marine Conservation Society in their Good Fish Guide and may leave you deciding to stop eating fish altogether. An uncomfortable read perhaps, but an essential one for anyone concerned with issues of sustainable food supplies.

■ **The End of the Line. C Clover, Ebury Press (www.randomhouse.co.uk), £14.99 ISBN 009189780-7**

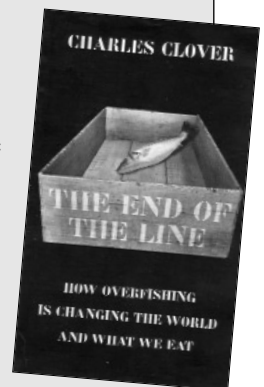


Table 2: Added vegetable oil in trout feed dramatically raises omega-6 & saturated fat content

	Trout fed without vegetable oil (% of oils in fish flesh)	Trout fed with vegetable oil (% of oils in fish flesh)
short chain omega-3	6	3
long chain omega-3	25	13
total omega-3	31	16
short chain omega-6	8	18
long chain omega-6	1	1
total omega-6	9	19
saturated fatty acids	19	28

Source: Bell et al, in Sargent and Tacon, *Proc Nut Soc*, 58, 1999