When I began my quest to market cod liver oil, the biggest hurdle I had to overcome involved the myths and inaccuracies that are discussed in the market place. After 18 months of research, I was comfortable placing my first order.

Eighteen months after making that first order it became apparent that to do justice to my efforts and to my customers, I needed to do a close-up, first hand study of the industry, including the harvesting and processing of raw materials and the various processing techniques to extract and purify the oil. I needed a full and unabridged understanding.

I have interviewed manufacturers, laboratories, fisheries, fish meal plants, fish farms and many fish oil mills throughout the world. The final phase of my work included a careful study of the facts to select a region of the world that offered the largest and most modern fish oil industry and then a personal visit and inspection of the various enterprises.

The culmination of my research was two weeks spent in Iceland and Norway visiting six different mills, a cod fish farm, fishing boats and a slaughter house.

COD LIVER OIL BY THE GLASS?

The Arctic explorer and anthropologist William Stefansson reports in his book Not By Bread Alone that "There are European districts where certain oils are drunk in limited quantities. For instance, Scandinavian fishermen often have a belief in the nearly magical value of cod or halibut liver oil, and some of them will toss off, most likely in the morning, the equivalent of a wineglassful." Among the Eskimos, however, "Nobody drinks large swigs of oil."

But the Eskimos did use seal oil in prodigious amounts. According to Dr. Price, "Seal oil provides a very important part of their nutrition. As each piece of fish is broken off, it is dipped in seal oil."

He noted that the Eskimos preserve foods like berries and sorrell grass in seal oil. "I obtained some seal oil from them and brought it to my laboratory for analyzing for its vitamin content. It proved to be one of the richest foods in vitamin A that I have found."

MEET MR. COD

The cod family (Gadus sp.) is one of the largest and most successful families of fish, found in all oceans of the world. There are more than 90 species of cod, of which 40 are commercially available as oils.

Even in the same waters, different species of the Gadus family can have great a variation in fatty acid profile and vitamin A and D content. In Norway, the species that produce the greatest concentrations of A and D are Gadus virens and Gadus pollachius. Their oils contain as much as to 5000 IU vitamin A and 500 IU vitamin D per gram. (That’s 25,000 IU vitamin A and 2500 IU vitamin D per teaspoon!). These two varieties are common in waters off the Shetland Islands. At the other extreme is Gadus gadiculus thori, which produces 500 IU vitamin A and 50 IU vitamin D per gram of oil – just one-tenth as much. This species is found close to the shores of Norway.

Cod also grows in fresh waters. The Great Lakes are host to a species of fresh water cod called burbot or "lawyers," which tests carried out during the 1940s indicated to be a very rich source of
vitamin D. Unfortunately, the Great Lakes fresh water cod has received little interest since then, and most recreational fishermen consider the burbot a nuisance fish.

The great difference in levels of fat-soluble vitamins is due principally to differences in enzymatic liver activity in the various cod species. Within the same species, feed, age and location will account for additional variations in the nutrient profiles of the oil.

Cod liver oil provides not only vitamins A and D, but also valuable fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). As with vitamins A and D, levels of EPA and DHA vary according to the species and the temperature of the waters in which they dwell. For example, Gadus morua from the Atlantic typically provides oil containing 8 percent EPA and 12 percent DHA while the same species in the Baltic Sea provides 9 percent EPA and 20 percent DHA. Another species, Gadus merluccius, typically has 17 percent EPA and 10 percent DHA.

THE CHANGING MARKET FOR COD LIVER OIL

Today, standards set by the United States Pharmacopeial Convention limit the level of A and D in cod liver oil to 2500 IU and 250 IU per gram respectively. EPA must fall in the range of 7-16 percent, and DHA in the range of 6-18 percent. One mill described this narrowing of definitions as a restriction on the market and opportunities, resulting in a tightening up of the market supply, as it excludes some species of cod that fall outside the EPA and DHA range of the specification. Many of the cod that fall outside the EPA and DHA guidelines are the species with higher vitamin liver oils. Two other market forces are likely to have an effect on the price and availability of good cod liver oil. One is the increasing demand and profitability of supplying fresh cod livers to the Eastern European market. These folks still understand the value of cod liver, and as their prosperity grows, so will their consumption of this nutrient-dense food.

The other force that is likely to cause fundamental changes in the cod liver oil market is the growing emphasis on ultra-clean fish oils along with a focus on fatty acids rather than natural high-vitamin content.

COD FARMING?

In my opinion, farmed cod is a long-term supply possibility as it is possible to farm the cod in a way that could reduce the risk of liver contamination through controlled feed. Furthermore, farmed cod is very different from most farmed fish in that a low 14 percent protein diet is preferred, thus limiting or eliminating the need for soy meal. Currently, limited cod fish farming takes place in the north Atlantic – my guess is that today less than 5 percent of the livers used for cod liver oil are from farmed cod – but fresh water cod could also be farmed in lakes and ponds throughout the world.

Most of the food for the cod is fish meal and oil and if the fish farm has incentives, careful selection of clean food can and is being used. The end result could be a cod that has limited exposure to most contaminants and an increase in the availability of good clean cod and cod livers.

The reason cod fish farms use a low-protein diet is because a high-protein diet produces cod with very large livers. The livers are a by-product and the fish farmer's efforts are focussed on growing the meat. A cod’s liver typically is 10-13 percent percent of the total fish weight. The liver oil is about 50 percent of the weight of the liver. One cod weighing 5 kilograms (about 11 pounds) renders about 8 ounces of cod liver oil.

Cod fish farming may become more and more necessary because of increasing pressure to limit the number of cod caught. Much of this pressure is coming from the European Union and environmental
activist organizations such as Green Peace. These groups view farmed cod as an environmentally friendly way to satisfy the growing demand for cod liver oil.

TRADITIONAL COD LIVER OIL PREPARATION

A description of traditional cod liver oil processing is provided by F. Peckel Möller in an article entitled "Cod-Liver Oil and Chemistry," published in London, 1895. "The primitive method... is as follows. As soon as the fishermen reach the Voer [pier], and finish separating the livers and roes, they sell the fish and carry the livers and roes up to their dwellings. In front of these are ranged a number of empty barrels into which the livers and roes are placed, separately of course. The fishermen do not trouble to separate the gall-bladder from the liver, but simply stow away the proceeds of each day's fishing, and repeat the process every time they return from the sea, until a barrel is full, when it is headed up and a fresh one commenced. This is continued up to the end of the season, when the men return home, taking with them the barrels that they have filled. The first of these, it may be noted, date from January, and the last from the beginning of April, and as on their arrival at their homes the fishermen have many things to arrange and settle, they seldom find time to open their liver barrels before the month of May. By this time the livers are, of course, in an advanced state of putrefaction. The process of disintegration results in the bursting of the walls of the hepatic cells and the escape of a certain proportion of the oil. This rises to the top, and is drawn off.

"Provided that not more than two or three weeks have elapsed from the closing of the barrel... to its being opened, and if during that time the weather has not been too mild, the oil is of a light yellow colour, and is termed raw medicinal oil. As may be supposed, however, very little oil of this quality is obtained. Indeed, as a rule there is so little of it that the fishermen do not take the trouble to collect it separately. Nearly all the barrels yield an oil of a more or less deep yellow to brownish colour: this is drawn off, and the livers are left to undergo further putrefaction. When a sufficient quantity of oil has again risen to the surface, the skimming is repeated, and this process is continued until the oil becomes a certain shade of brown. The product collected up to this point is known as pale oil... By this time the month of June has generally been reached, and with the warmer weather the putrefaction is considerably accelerated, and the oil now drawn off is of a dark brown colour, and is collected by itself. It is rather misleadingly called light brown oil... When no more can be squeezed out, the remainder is thrown into an iron caldron and heated over an open fire. By this process, the last rests of oil are extracted from the hepatic tissues, which float about in the oil like hard resinous masses... In order to fully carry out the extraction, it is necessary to raise the temperature considerably above the boiling point of water... The oil prepared in this way is very dark, almost black, and with a greenish fluorescence in reflected light. In thin layers and by transmitted light it shows a brown colour, and it is therefore termed brown oil..."

The writer then describes processing methods introduced to Norway in the 1850s by Peter Möller, which resulted in a much purer, consistently light-colored oil made from fresh, not putrefied livers, considerably more palatable in terms of taste and smell. He notes, however, that the "brown oils are actually used to a certain extent for medicinal purposes at the present day." Perhaps the dark brown oils contained, in addition to vitamins A and D, vitamin B12 and other nutrients from the hepatic tissues.

MANUFACTURING

On my recent trip, I visited six cod liver oil mills in Iceland and Norway. Each mill was no older than two years and they all had identical protocols, plant layout and equipment.
I learned that there are five steps to the refining process:

**Alkali refining**, which removes free fatty acids and some metals (I view this is as a type of chelation operation.)

**Bleaching**, which removes color substances, metals and dioxins. This is a chelation-type of process that uses clay or other natural earth absorbents.

**Winterization**, which removes sterins (saturated fats). This is a cold press or filter type of operation.

**Deodorization**, which removes pesticides, PCBs, most of vitamin D and quite a bit of the vitamin A.

**Add vitamins** (either natural or synthetic) to meet standards or the requirements of the retailers.

Each of the first three stages removes some vitamins but it is the deodorization step that takes out the most. This is why processors then add the vitamins back in. The shocking discovery I made is that usually the vitamins added are synthetic – retinol palmitate and vitamin D3 made by irradiating lanolin with ultra-violet light.

All but one of the mills I visited adds back synthetic vitamins. The mill that adds natural vitamins takes the time to collect the vitamins from the oil and clean the oil of contaminants, then add the natural vitamins back into the final product. This is an old technology, with a few proprietary twists, which used to be common. The industry views this process as cost prohibitive in today’s marketplace and the risk is that it will be phased out completely. My hope is that as demand for high-vitamin cod liver oil containing only natural vitamin A and D increases, more manufacturers will use this technology.

Thus, the cod liver oils on the market today fall into one of four categories:

**Fully cleaned and deodorized with nothing added back in.** These oils have a reduced vitamin A content and virtually no vitamin D. This type of cod liver oil might be appropriate for life guards and others who spend a lot of time in the sun, and who want the benefits of vitamin A, EPA and DHA without overdosing on vitamin D. But since vitamin D works synergistically with vitamin A, this would not be a good choice for most of us.

**Non-deodorized with a fair amount of natural vitamin A and D left.** According to the company website, Garden of Life cod liver oil falls in this category. It contains 500-1500 IU vitamin A per gram (2500-7500 IU per teaspoon) and 100-175 IU vitamin D per gram (500-875 IU per teaspoon).

**Fully cleaned and deodorized cod liver oil with synthetic vitamins added back in.** Most of the cod liver oils on the market fall into this category. (You’ll need to check with the individual manufacturer to verify whether their cod liver oil falls in this category.) These vary in dose from about 1100 to 4600 IU vitamin A per teaspoon and 180 to 460 IU vitamin D per teaspoon.

**Fully cleaned and deodorized, with natural vitamins added back in, standardized at 2340 IU vitamin A per gram (11,700 IU per teaspoon) and 234 IU vitamin D (1170 IU per teaspoon).** This is the type of cod liver oil sold as Blue Ice and by Radiant Life and Dr. Ron’s UltraPure.

**DEODORIZATION**

The deodorization step is a new technology and replaces molecular distillation that many mills formerly used to fully clean the oil.
In molecular distillation, the oil is heated under a vacuum to about 190°C by direct heat on a hot surface. The volatile compounds are distilled from the oil.

The newer deodorization process heats the oil to 170-180°C by flushing steam through it. The steam removes the volatile compounds and carries them out. As the heat is indirect and the temperature lower than distillation, there is less likelihood of damage to the polyunsaturated fatty acids. The new deodorization process is more efficient in removing compounds that impart flavor and odor to the oil—which is why the process is called "deodorization." This, according to the industry, is a real advantage because "the oil is of better sensoric quality than before."

To summarize, the benefits of deodorizing (compared to molecular distillation) include a lower peroxide value, better flavor and odor, and a cleaner product. The disadvantages include a much lower natural vitamin A content and virtually no vitamin D.

IS ULTRA-CLEAN REALLY NECESSARY?

But are either deodorization or molecular distillation necessary? The industry says yes. According to the owners of one mill I visited: "We have done some tests on non-deodorized CLO and have observed … dioxin-like PCB's at a concentration of 6-8 picograms TE [WHO designation of Toxic Equivalent] per gram and some pesticides are also observed."

However, during my studies, I talked to two fish oil scientists and one marine biologist who questioned the necessity for ultra-clean oils. They did not want to go on record but this is what they said in a nutshell: There have been metals, dioxins and PCBs in fish livers and our environment since the beginning of time. And while there may be a difference between man-made contaminants and naturally occurring contaminants, there are just as many or more contaminants in tomatoes and strawberries than in most fish oils. Left unsaid was the fact that vitamin A in cod liver oil protects against dioxins and pesticides. Much of this protective nutrient is removed in the process of making the oil ultra-clean.

They also believed that concerns for mercury content in cod liver oil were misplaced, explaining that mercury has always been in the sea. The red color in plankton is methyl mercury. Plankton is the grass of the sea. Methyl mercury has always been part of man's diet through the consumption of ocean fish. Said one of my interviewees: "One day we may find that some of the contaminants are actually nutrients."

VITAMIN A TOXICITY – IT’S THE FORM THAT MATTERS

Many warnings against taking too much vitamin A permeate the scientific literature, yet primitive peoples consumed very high levels of this nutrient and enjoyed excellent health. A recent study, published in the American Journal of Clinical Nutrition (December 2003), solves the apparent contradiction. Researchers performed an extensive literature review to create a database of 259 cases of vitamin A toxicity, as chronic (from long-term ingestion), acute (from short-term ingestion) and teratogenic (causing birth defects). Symptoms of toxicity included problems with skin, hair, vision and the nervous and gastrointestinal systems (such as vomiting). Adult subjects of chronic hypervitaminosis A experienced mostly symptoms of the gastrointestinal system and skin and hair, and symptoms of a deteriorating state of health.

The remarkable finding was that vitamin A taken in emulsified, water-miscible (mixable in water) and solid form was ten times more toxic than vitamin A taken in oil-based preparations. Chronic hypervitaminosis A is induced after daily doses of 2 mg retinol per kilogram of body weight in oil-
based preparations for many months or years while acute toxicity is induced in daily doses as low as 0.2 mg retinol per kilogram of body weight in water-miscible, emulsified and solid preparations for only a few weeks. Expressed in terms of International Units, this works out to about 200,000 IU per day for adults and 20,000 IU per day for children of oil-based preparation and 40,000 IU per day for adults and 4,000 IU per day for children of water-miscible, emulsified and solid preparations.

The US Recommended Daily Allowance for vitamin A is 1000-2000 IU for children, depending on age, 2330 for women, and 3000 IU for men, well below the range of toxicity for even the non-oil-based forms, although some cases of toxicity have been reported in children, even with these low dosages. In adults, several conditions enhance retinol toxicity, including alcohol ingestion, low-protein intakes, viral hepatitis, environmental pollutants and drugs, and diseases of the liver and kidney. As for the oil-based form of vitamin A, the toxic dose is well above the amount one would ingest by following our dietary recommendations of cod liver oil, eggs, butterfat and liver at least once a week. The report notes that clinical studies of secondary cancer prevention indicate that daily doses of 90 mg retinol (over 300,000 IU), in adults are well tolerated for many months or years; the adverse clinical side effects reported after 1-2 years of treatment were mild dermatologic symptoms in 40-55 percent of subjects. By contrast, a similar dose of retinol in a water-miscible and emulsified form given daily for 12 months resulted in earlier and more pronounced side effects.

Interestingly, the researchers found that vitamin D appears to protect against retinol toxicity, which means that natural cod liver oil, with its combination of vitamin A and D, is particularly safe. This ground-breaking review reveals the fallacy – even the danger – of vitamin A fortification programs. Currently many third world countries are engaging in programs to add vitamin A to corn flour and sugar as a way to combat widespread health problems due to vitamin A deficiency. Vitamin A is also often added to powdered dry milk, a key commodity in food giveaway programs. In some European countries, vitamin A is added to liquid milk, including (and mostly) low-fat milk, a fact that explains the correlation in some studies of high vitamin A intake with increased risk of osteoporosis.

The researchers did not specify the type of vitamin A in oil-based preparations – was it natural vitamin A in (or added back to) cod liver oil, or synthetic vitamin A in cod liver oil or some other kind of oil? In any case, this study indicates that as far as toxicity is concerned, even synthetic vitamin A is safe when added to cod liver oil. It may not be as effective or beneficial, however, because natural vitamin A is composed of a variety of isomers that have varying degrees of activity and play a variety of roles in the body chemistry.

OILS FROM ELSEWHERE

I did locate other natural high-vitamin cod liver oils produced in a low-tech manufacturing environment in many parts of the world, such as China and India, but what I found was an industry that did not measure or care about contaminant levels. I discussed these oils with various representatives of the industry and they confirmed my findings. "Rarely do we find a contaminated fish oil from the North Atlantic region. Maybe one in a hundred fish oil samples we will find a contaminant and usually it will be very minimal, perhaps one element slightly higher than standard out of several hundred tested. We do find contaminated fish oils from other parts of the world, such as China."

FOCUS ON PURITY

Purity will be the focus as the industry readies for a big boom in the fish oil market. This big boom will be driven by food manufacturing and the pharmaceutical industry. The emphasis will be – indeed already is – on the fatty acids EPA and DHA, not the vitamins, since the vitamins are removed by the processing and the fatty acids are not. Natural vitamin cod liver oil is not wagging the dog in this new
emerging market. In my opinion, good quality cod liver oil, as defined by oil that is clean and contains a natural high-vitamin content, has the potential to become a thing of the past as this product is no longer a focus of the market, in fact hasn't been for years.

It seems to me that development of a quality cod liver oil manufacturing ability in the US – where there is growing consumer demand for such a product – is a necessary step to ensure the continued existence of this endangered species.

**LAWYERS TO THE RESCUE**

If it is not necessary to purify cod liver oil – and if obtaining high-vitamin cod liver oil is going to become more and more difficult – resourceful folk can fill the gap by making their own, as the Eskimos did. That means keeping the livers from those "lawyers" you catch, simmering them in water and then chilling to remove the oil. And since cod can be farmed, why not grow them in clean, freshwater ponds on farms throughout America? That way, when you pick up your meat, dairy products and eggs at the farm store, you can pick up locally produced cod liver oil as well.

**SOME STUDIES ON COD LIVER OIL**

1937: When calcium plus viosterol (synthetic vitamin D2) was given to pregnant women, researchers found definite calcification of the placenta and indications of adverse effects (such as calcification of the kidneys) in newborns. No such effects occurred with calcium plus cod liver oil, a source of natural vitamin D (Ohio State Medical Journal 33(9):990-994).


2003: Supplementation during pregnancy and lactation with cod liver oil resulted in higher IQ in offspring at 4 years of age (Pediatrics 111(1):e39-e44).


2004: Researchers relate the recent decline in cardiovascular disease mortality in Norway to increased use of cod liver oil, among other factors (Medisin Og Vitenskap 124:1532-6).

2005: Women who took cod liver oil during pregnancy were 11 times more likely to give birth to normal-weight babies, thus avoiding the many health problems to which low-birth-weight babies are prone (British Journal Gynecology and Obstetrics, April 2005).

**About the Author**

Thanks to David Wetzel, both high-vitamin cod liver oil and high-vitamin butter oil are available in America. He serves as local chapter leader in Page, Nebraska.

http://www.westonaprice.org/modernfood/codliver-manufacture.html