

Phospholipids: A Hidden Superpower for Your Health

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STORY AT-A-GLANCE

- › Unlike krill oil – a superior source of omega-3 fats – fish oil lacks phospholipids, which increase omega-3 fat absorption and provide other benefits
- › A new lysophospholipid form of DHA shows promise for preventing the visual decline that often occurs alongside chronic diseases like Alzheimer’s and diabetes
- › While the DHA in most fish oil supplements cannot reach the retina, where DHA concentrates, LPC-DHA crosses into the retina from the bloodstream
- › Krill oil counteracts neuroinflammatory processes, due to its phospholipids and additional beneficial compounds, like astaxanthin
- › Although krill oil contains less EPA and DHA per gram of supplement than fish oil does, it’s more bioavailable since the EPA and DHA are bound in a phospholipid form

You’ve likely heard about the many benefits of omega-3 fats for your heart, brain and more, but if you’re consuming it in supplement form, be sure it’s alongside phospholipids. Wild-caught salmon, sardines and certain other fish are excellent sources of the omega-3 fats eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).¹

However, because most Americans do not consume much seafood, many rely on fish oil supplements instead. This is a mistake for virtually anyone who makes this choice. This is because the chemical process used to make most of these products – trans-

esterification – transforms the oil into a synthetic product that’s far removed from the natural fats you’d get when eating sardines or other fatty fish.²

There are many issues with synthetic fish oil, and absorption is only one of them. Free fatty acids of fish oil have an absorption rate of at least 95%. EPA in its natural triglyceride form had a 68% absorption rate in one study, while ethyl ester forms – the type found in nearly all fish oil supplements – absorbed only about 20% as well as the free fatty acids.³

Unlike krill oil – a superior source of omega-3 fats – fish oil lacks any phospholipids. Research is now confirming just how important the phospholipid component is when it comes to gleaning all the benefits you can from your omega-3 fats.

Phospholipid Form of Omega-3 Helps Prevent Visual Decline

Recent studies show a new lysophospholipid form of DHA (LPC-DHA) shows promise for preventing the visual decline that often occurs alongside chronic diseases like Alzheimer’s and diabetes, according to a study presented at the 2023 annual meeting of the American Society for Biochemistry and Molecular Biology.⁴ While the DHA in most fish oil supplements cannot reach the retina, where DHA concentrates, LPC-DHA crosses into the retina from the bloodstream.

“Increasing the retinal DHA at clinically feasible doses has not been possible until now because of the specificity of the blood-retinal barrier that is incompatible with the specificity of the intestinal barrier,” study author Sugasini Dhavamani explained. “This study uses the novel approach of dietary LPC-DHA that overcomes both intestinal and blood-retinal barriers and improves retinal function.”⁵

In order to reach the retina, the DHA must first be absorbed from the intestine into the bloodstream and from there cross into the retina. The study, which involved mice, found that not only did LPC-DHA increase DHA in the retina, it reduced eye problems related to Alzheimer’s disease.⁶ Mice fed LPC-DHA daily for six months had a 96% increase in DHA and signs that the structure of the retina was better preserved.⁷

Low levels of DHA in the retina are common in people with Alzheimer's, diabetes and age-related macular degeneration (ARMD), and if you don't have enough DHA in the retina it's associated with vision loss. Dhavamani explained:⁸

"Dietary LPC-DHA is enormously superior to TAG-DHA [triacylglycerol DHA, the type found in fish oil supplements] in enriching retinal DHA and could be potentially beneficial for various retinopathies in patients. This approach provides a novel therapeutic approach for the prevention or mitigation of retinal dysfunction associated with Alzheimer's disease and diabetes."

While these certainly are impressive results, they certainly are not novel and essentially replicate the characteristics of the phospholipids that are in krill and have been well-documented for many decades.

Krill Oil Protects Against Cognitive Impairment

Typically, DHA and EPA are water insoluble and therefore cannot be transported in their free form in your blood. They must be packaged into lipoprotein vehicles such as a phospholipid. This is primarily why the bioavailability of krill oil is so much higher than fish oil, because in fish oil, the DHA and EPA are bound to triglycerides.

Many studies highlight krill oil's effectiveness, including for brain health. In an animal study, krill oil had a beneficial effect on neuroinflammation and oxidative stress, which are associated with the development of Alzheimer's disease. In mice with Alzheimer's disease, krill oil also inhibited memory loss.⁹

Writing in the journal *Neuroscience Research*, scientists from Central Michigan University again highlighted krill's unique position to counteract neuroinflammatory processes, due to its phospholipids and additional beneficial compounds, like astaxanthin:¹⁰

"Similar to the more widely studied fish oil, KO [krill oil] contains the long chain fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are essential for basic brain functions."

Moreover, the phospholipid bound nature of fatty acids found in KO improves bioavailability and efficiency of absorption, thus supporting the belief that KO may offer a superior method of dietary n-3 delivery. Finally, KO contains astaxanthin, an antioxidant capable of reducing potentially excessive oxidative stress and inflammation within the brain.”

Krill Oil Protects Neurons From Age-Related Degeneration

In another example, this time involving roundworms and human cells to investigate whether krill oil promotes healthy aging, a number of hallmarks of aging were modified. “There is accumulating evidence that interfering with the basic aging mechanisms can enhance healthy longevity,” the team noted.¹¹

In a model of Parkinson’s disease, krill oil protected dopaminergic neurons, which synthesize the neurotransmitter dopamine, from aging-related degeneration while improving behaviors and cognition that depends on dopamine.

“Krill oil rewires distinct gene expression programs that contribute to attenuating several aging hallmarks, including oxidative stress, proteotoxic stress, senescence, genomic instability, and mitochondrial dysfunction,” according to the researchers.¹²

They suggested krill oil increases neurons’ resilience by helping to ward off inflammation and oxidative stress – “thus,” they note, “krill oil supplementation might serve as a possible approach for healthy brain aging interventions.”¹³

Krill Offers Unique Benefits for Iron Overload, Choline

Why else is krill oil, with its valuable phospholipids, so valuable? Research suggests it alleviates oxidative stress and iron accumulation, such that it could be used as a treatment for toxicity caused by iron overload which is pervasive in most adults.¹⁴

Krill oil is also a particularly good source of choline. While choline is found in a variety of foods, intakes for adults and children are believed to be far below optimal levels, putting

public health at risk and leading experts to suggest that [intake of choline-rich foods should be encouraged].¹⁵

Krill oil contains 69 choline-containing phospholipids to synthesize phosphatidylcholine, a critical component of human cell membranes.¹⁶ This is key to its benefits as a source of choline, because it's estimated that 60% of choline in organic salts is otherwise lost when gut bacteria convert it to the metabolite trimethylamine (TMA).

Enzymes then turn TMA into trimethylamine-N-oxide (TMAO), a potential biomarker for insulin resistance and heart problems. Krill oil, however, contains fatty acids in the form of phosphatidylcholine (PC) – unlike fish oil, which contains them in triglyceride form.

As noted by the researchers, “Choline in the form of PC is considerably less converted to TMA as demonstrated in a single-dose study with krill oil,¹⁷ potentially resulting in more efficient delivery of choline.”¹⁸ It's been shown for instance, that 28 days of krill oil supplementation increased choline levels in healthy young adults.¹⁹

In a study comparing phosphatidylcholine, present in krill oil, and choline bitartrate salt, it was found that the krill oil led to higher levels of the important metabolites betaine and dimethylglycine (DMG) along with lower levels of TMAO, which can lead to health issues, compared to the other choline source. Researchers explained:²⁰

“Krill oil is increasingly recognized as a useful source of phosphatidylcholine, in addition to its acknowledged role in providing the omega-3 fatty acids EPA and DHA. In a former study, phosphatidylcholine was shown to raise plasma choline levels more efficiently compared to ingestion of free choline as choline chloride.”

With Krill Oil, You Get Astaxanthin

It's worth mentioning that when you choose omega-3s in the form of krill oil, you also get some astaxanthin, an antioxidant produced by the microalgae *Haematococcus pluvialis* when its water supply dries up, forcing it to protect itself from UV radiation.

Besides the microalgae that produce it, the only other sources are the sea creatures that consume the algae, such as wild salmon, shellfish and krill.

Many researchers believe astaxanthin is the most powerful antioxidant ever discovered for eye health.^{21,22} It has protective benefits against a number of eye-related problems, including ARMD and cataracts, as well as:

- Cystoid macular edema
- Diabetic retinopathy²³
- Retinal arterial occlusion and venous occlusion
- Glaucoma²⁴
- Inflammatory eye diseases (retinitis, iritis, keratitis and scleritis)

Astaxanthin easily crosses into the tissues of your eye and exerts its effects safely and with more potency than any of the other carotenoids, without adverse reactions. Specifically, astaxanthin has been shown to ameliorate or prevent light-induced damage, photoreceptor cell damage,²⁵ ganglion cell damage and damage to the neurons of the inner retinal layers.

Research published in the Journal of Clinical Biochemistry and Nutrition in 2017 showed 16 weeks of astaxanthin supplementation protected against wrinkles and loss of skin moisture, and improved skin elasticity.²⁶

Most Fish Oil Supplements Should Be Avoided

I recommend avoiding nearly all commercial fish oil supplements, because the DHA and EPA are delivered in the form of ethyl esters. These are essentially a synthetic substrate, created through the microdistillation process of crude fish oil, in which ethanol and/or industrial alcohol is added. This mix is heat distilled in a vacuum chamber, resulting in a concentrated omega-3 ethyl ester condensate.

Not only does this molecular distillation process remove vital resolvins and protectins that are important in reducing inflammation, but it also concentrates the EPA and DHA. You can tell the concentration of these two fats in any given supplement by looking at the label. In fish, the oil consists of 20% to 30% EPA and DHA, whereas purified fish oil concentrate typically contains between 60% and 85% EPA and DHA.²⁷

Most corporations produce ethyl ester fish oil because it's far less expensive to produce than the triglyceride form. Ethyl esters are also easier to work with during processing, as they have a higher boiling point, which becomes important when the oils are heated and purified of environmental pollutants.

Ethyl esters are the least bioavailable form of omega-3. Manufacturers could convert them back into the triglyceride form by detaching the ethyl alcohol molecule and reattaching a glycerol molecule in a process known as re-esterification,²⁸ but most don't because it's so costly.

Your Body Metabolizes Ethyl Ester Forms Differently

It's important to understand that your body metabolizes the triglyceride and ethyl ester forms of omega-3 differently, and this is when the issues arise. Since the glycerol backbone is missing in the ethyl ester form, the EPA and DHA will scavenge for available triglycerides or steal a glycerol molecule from somewhere.

The fatty acids need to be converted back into triglyceride form or your gut epithelium will not be able to process them. When the ethyl ester form of EPA or DHA ends up stealing glycerol molecules, the molecule that lost its glycerol will then go searching for a replacement, creating a negative domino effect. Further, the fatty acids cannot be transported through your blood unless they're in triglyceride form.

On the other hand, when you consume omega-3s in triglyceride form, the fatty acids are first separated from the glycerol backbone. All of the individual parts are then absorbed by gut epithelial cells, where they're reattached to form triglyceride.

When you consume ethyl esters, they must be processed in your liver. There, the ethanol backbone is separated from the free fatty acids, and your body must then reattach the free fatty acids to glycerol to form triglyceride. Your liver must also process the ethyl alcohol, which may release free radicals and cause oxidative stress – the opposite of what you're trying to achieve when you consume fish oil.

Ideally, consume omega-3 fats in whole-food form by eating fatty, cold-water fish. This includes wild-caught Alaskan salmon, sardines, anchovies, mackerel and herring. If you choose to use a supplement, krill oil provides a superior alternative to fish oil.

Although krill oil contains less EPA and DHA per gram of supplement than fish oil does, it's more bioavailable since the EPA and DHA are bound in a phospholipid form. This means you can take lower doses while reaping superior results.

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