MERCOLA
Take Control of Your Health

Choline in Eggs Reduces Inflammation

Analysis by Dr. Joseph Mercola | December 11, 2023

STORY AT-A-GLANCE

- Choline is a crucial nutrient for healthy fetal development and the function of your brain, nervous system, mitochondria and cardiovascular system. It also plays a role in metabolism and DNA synthesis
- According to recent research, eggs, which are rich in choline, have anti-inflammatory activity and can be particularly useful in those with insulin resistance and/or metabolic syndrome
- A small amount of choline is produced by your liver. The rest must be supplied through your diet. The recommended adequate intake for choline is about 550 milligrams a day, but many get nowhere near this amount. Some estimates suggest 90% of the U.S. population is deficient in choline
- Studies have linked higher choline intake to a range of benefits, including a decreased risk for heart disease, a 24% decreased risk for breast cancer, and the prevention of nonalcoholic fatty liver disease (NAFLD)
- NAFLD is the most common form of liver disease in the U.S., and prevalence has skyrocketed among children in recent years. Choline deficiency may be driving factor in this trend because if you don't have enough choline, any dietary fat, and any food the liver can turn into fat, such as refined sugar and ethanol (alcohol), will promote the accumulation of liver fat

Choline, found in ample amounts in organic, pastured egg yolks, was first discovered in 1862.[1] It was officially recognized as an essential nutrient for human health by the

Institute of Medicine in 1998.[2] Since then, we've learned that choline has a long list of health benefits. For example, it's required for:

Healthy fetal development[3]	**Optimal brain function, memory and cognition**
Nervous system health — Choline is necessary for making acetylcholine, a neurotransmitter involved in healthy muscle, heart and memory performance	**Cell structure —** Choline is needed for the synthesis of phosphatidylcholine, better known as lecithin, which is required for the composition of cell membranes
Mitochondrial function[4]	**Metabolism** (energy production)
DNA synthesis	**Methylation reactions**[5]
Cardiovascular health	**Liver health**, as choline is needed to carry cholesterol from your liver; a choline deficiency could result in excess fat and cholesterol buildup[6]

Eggs Lower Inflammation and Insulin Resistance

Research published in 2020 also concluded that choline has anti-inflammatory activity and can be particularly useful in those with insulin resistance and/or metabolic syndrome. And, while a choline supplement was good in this regard, eggs were far better. As reported by the authors:[7]

> *"Metabolic syndrome (MetS) is characterized by low-grade inflammation and insulin resistance, which increase the risk of heart disease. Eggs have numerous nutrients including choline, carotenoids, and fat-soluble vitamins that may protect against these conditions. Egg phosphatidylcholine (PC) is a major contributor of dietary choline in the American diet.*

> *In this study, we evaluated the effect of two sources of choline, whole eggs (a source of PC) and a choline supplement (choline bitartrate, CB), on plasma lipids, glucose, insulin resistance, and inflammatory biomarkers.*"

Twenty-three subjects diagnosed with metabolic syndrome were included in the study. After a two-week washout period with no choline intake, participants were randomly allocated to consume either three eggs per day or 400 mg of choline bitartrate per day for four weeks.

> **"Both choline supplementation and eggs reduced interleukin-6 (IL-6) levels, but eggs also resulted in lower C-reactive protein, insulin, and insulin resistance compared to baseline."**

After a three-week washout period, they were then given the alternate treatment. While eating eggs, participants were found to have higher levels of vitamin E and selenium, but there were no differences in cholesterol levels, triglycerides or glucose compared to baseline or when they were on the choline supplement.

Interestingly, both choline sources reduced interleukin-6 (IL-6) levels, but eggs also resulted in lower C-reactive protein, insulin and insulin resistance compared to baseline, causing the authors to conclude that:[8]

> *"... in a MetS population, intake of three eggs per day does not increase plasma LDL cholesterol, and has additional benefits on biomarkers of disease compared to a choline supplement, possibly due to the presence of other antioxidants in eggs.*"

Egg Yolks Are a Superfood

I believe egg yolks are one of the two most nutrient-dense foods in existence. The other is organ meats. I eat three eggs twice a day for a total of six a day, and getting enough

choline is one of the reasons why I do this. However, I separate the yolks from the whites and only eat one egg white a day. The egg white is cooked because of the avidin that it contains that binds to biotin if it is uncooked.

The reason for this is because egg whites are very high in tryptophan, a precursor to serotonin, which you want to seriously limit because of serotonin's damaging effects on your body. I explained more details in "**What You Need to Know About Estrogen and Serotonin**." The yolk is where most of the essential nutrients are, including the healthy fats.

The caveat here is that you need to be mindful of where you get your eggs from, as the nutritional quality of the eggs is dependent on the diet of the chickens. The egg yolks of eggs from confined animal feeding operations (CAFOs) can be relatively high in **linoleic acid (LA)**, if you eat more than four a day.

The reason I'm comfortable eating half a dozen egg yolks a day is because I feed my chickens a special diet resulting in the egg yolks having 75% lower linoleic acid (LA) content than conventional eggs.

It is best to limit your intake of LA to below 5 grams (5,000 mg) per day. Sadly, virtually all chicken eggs in the U.S. will put you over 5 grams per day if you are eating six per day like I am. This is because virtually all chickens are fed grains that high in LA. This is true even for pasture-raised organic chickens.

How to Feed Chickens to Get the Lowest Possible LA

There are only a handful of chicken growers that understand and feed their chickens food that is much lower in LA. I learned this trick from Ashley Armstrong, a regenerative farmer who is one of the leaders in optimizing feed for chickens in the U.S. in order to meet ancestrally-based low LA standards.

I will be interviewing her in a few weeks for her insights into this process. She is also an avid follower of biologist and bioenergetic medicine pioneer Ray Peat's principles, so we will have a grand time when we connect in our interview. She has a small farm of only a

few thousand chickens, but is in the process of creating a nationwide network to make these types of eggs more widely available.

Her eggs are not cheap, with shipping cost around $20 a dozen. But they are absolutely top notch. Ideally, it would be best to raise your own chickens like I do so you can avoid these high prices and have a sustainable source of one of the highest quality foods on the planet.

I am sure Ashley and I will go into more details in our interview, but the recipe is fairly simple as there are only three ingredients. The first is white rice. This is not a mistake; brown rice is vastly inferior, as the hulls will tend to catalyze endotoxin production in the chicken's gut.

Then I use split peas and soak them for 12 days and rinse every 12 hours until I cook them in a pressure cooker after two days. So, essentially, they are sprouted and pressure-cooked split peas. Ashley doesn't cook her split peas because that is tough to do in a large commercial operation. Finally, I add barley to their feed. I also sprinkle in some calcium powder, minerals and my desiccated liver powder.

Alternatives to Raising Your Own Chickens

If I weren't raising my own chickens, which gives me the ability to control the LA content of my eggs, I probably would not eat more than three egg yolks a day, as three conventional egg yolks will, by themselves, nearly max out your recommended LA intake for the day.

An alternative to raising your own chickens is to buy your eggs from a farmer you know has not fed the chickens conventional grains, which are high in both LA and toxic agricultural chemicals like glyphosate. You can share the formula above with him and the interview I will be doing with Ashley in about three weeks.

Cofounder of the regenerative farm Angel Acres,[9] she raises goats, chickens and lambs. As I said earlier, at $20 for a dozen eggs, their eggs are quite expensive, but, other than

my own eggs, they're among the best quality eggs I've come across. To evaluate other brands, check out The Cornucopia Institute's **Organic Egg Scorecard for 2023**.[10]

Choline Deficiency May Be a Primary Driver of NAFLD

Studies have linked higher choline intake to a range of benefits, including a decreased risk for heart disease,[11] a 24% decreased risk for breast cancer,[12] and the prevention of nonalcoholic fatty liver disease (NAFLD).

In fact, choline appears to be a key controlling factor in the development of fatty liver, in part by enhancing secretion of very low density lipoprotein (VLDL) particles,[13] which are required to transport fat out of your liver, and in part by carrying cholesterol from your liver.

In these ways, choline helps prevent the buildup of fat and cholesterol.[14] Research has also discovered evidence of epigenetic mechanisms of choline,[15] which also helps explain how choline helps maintain healthy liver function.

NAFLD is the most common form of liver disease in the U.S., and **prevalence has skyrocketed among children** in recent years. According to Chris Masterjohn, who has a Ph.D. in nutritional science, choline deficiency is likely a driving factor in this trend because if you don't have enough choline, any dietary fat, and any food the liver can turn into fat, such as refined sugar and ethanol (alcohol), will promote the accumulation of liver fat.

And, once fat accumulation has set in, excessive consumption of polyunsaturated fats (PUFAs) from seed oils will fuel inflammation by increasing lipid peroxidation and decreasing DHA levels (as PUFAs contain high amounts of omega-6 and most people don't get enough omega-3 from their diet). As explained by Masterjohn in a 2010 article:[16]

> *"We now know that choline is necessary to produce a phospholipid called phosphatidylcholine (PC) … a critical component of the very low density*

lipoprotein (VLDL) particle, which we need to make in order to export fats from our livers.

The amino acid methionine can act as a precursor to choline and can also be used to convert a different phospholipid called phosphatidylethanolamine directly into PC. Thus, the combined deficiency of choline and methionine will severely impair our abilities to package up the fats in our livers and to send them out into the bloodstream."

Choline Helps Prevent Neurodegenerative Diseases

Choline also helps protect against neurodegenerative brain diseases such as Alzheimer's, by:

- **Reducing your homocysteine level**, an amino acid shown to cause neurodegeneration and is involved in the formation of amyloid plaques, two hallmarks of Alzheimer's. Choline converts homocysteine into methionine, which has beneficial effects.
- **Inhibiting microglia activation —** Microglia cells clear debris from your brain, and while this is a crucial function, in Alzheimer's the microglia have a tendency to become overactivated, causing inflammation in the brain that can result in the death of neurons. By reducing activation of microglia, choline can help protect Alzheimer's patients from further brain damage.

Interestingly, animal research[17] has also shown that high choline intake during the prenatal period helps prevent neurodegenerative diseases in the offspring. In other words, it has multigenerational effects. This is all the more reason for pregnant women to make sure they're getting enough choline.

Most People Need More Choline

Although a small amount of choline is produced by your liver,[18] the rest must be supplied through your diet. The recommended "adequate intake" for choline is about 550 milligrams a day,[19] but many get nowhere near this amount. My daily six eggs provide me with about 800 mg of choline.

In fact, estimates suggest 90% of the U.S. population may be deficient in choline.[20] Some of the symptoms associated with low levels include memory problems, lethargy and persistent brain fog. People who are at particularly high risk for deficiency include:

- **Pregnant mothers —** Choline is required for proper neural tube closure,[21] brain development and healthy vision.[22] Research shows mothers who get sufficient choline impart lifelong memory enhancement to their child due to changes in the development of the hippocampus (memory center) of the child's brain.[23] Choline deficiency also raises your risk of premature birth, low birth weight and preeclampsia.
- **Athletes —** Endurance exercise deplete choline, and supplementation before severe physical stress has several advantageous effects.[24,25] Choline supplementation may also reduce body mass without side effects.[26]
- **High alcohol consumers —** Excess alcohol consumption can increase your need for choline and raise your risk of deficiency.[27]
- **Vegans —** This demographic is at increased risk for deficiency as they avoid several of the most choline-rich foods, eggs, organ meats and beef in particular.[28]

Also, keep in mind that requirements can vary widely, depending on your overall diet, age, ethnicity and genetic makeup. As noted in one paper,[29] "People with one of several very common genetic polymorphisms in the genes of choline metabolism are more likely to develop hepatic dysfunction when deprived of choline."

Another study[30] found that in some men, 550 mg of choline per day was insufficient as they still developed organ dysfunction. Postmenopausal women were also more prone to develop signs of organ dysfunction than premenopausal women when deprived of adequate amounts of choline for just under six weeks.

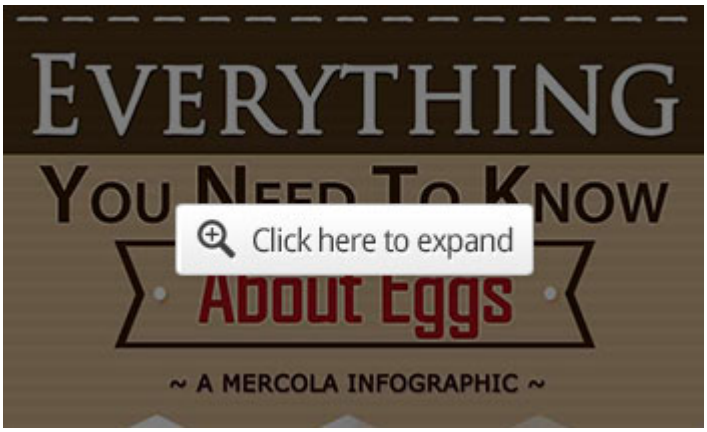
If you already have NAFLD, you'd be wise to pay careful attention to choline as well. A study on the severity of NAFLD found that low choline intake significantly increased symptoms, including fibrosis (the thickening and scarring of connective tissue).[31]

The tolerable upper intake level for choline is 3.5 grams (3,500 mg) per day. Side effects of excessive choline include low blood pressure, sweating, diarrhea, and a fishy body odor.[32]

Healthy Choline Sources

A single egg yolk contains about 125 mg of choline,[33] or about 23% of your daily requirement, making it one of the best choline sources in the American diet. Only grass fed beef liver beats it, with 430 mg of choline per 100-gram serving.[34] Other good sources of choline include:[35]

Chicken liver, 247 mg per 3 ounces	Wild-caught salmon, 187 mg per 3 ounces
Shitake mushrooms, 58 mg per one-half cup	Chicken, 56 mg per 3 ounce
Beef (grass-fed strip steak), 55 mg per 3 ounce	Wheat germ, 51 mg per ounce
Raw milk, 38 mg per 8 ounce	Brussels sprouts, 32 mg per one-half cup
Krill oil[36]	



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