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The Long and the Short of Omega-3 Nutrition

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For decades, Americans' consumption of omega-3 fatty acids, whether from fish, flax, walnuts or avocados, has declined in favor of omega-6 fatty acids, especially as found in corn, sunflower, soy, cottonseed, safflower oil and grain-fed beef.[1]

Deficiencies in omega-3 fatty acids, especially when the diet is heavily skewed towards omega-6 consumption, are associated with a wide range of pathophysiologies ranging from criminal behavior to heart disease, arthritis, diabetes, skin and eye diseases, and mental and mood disorders.[2] We have only recently become relatively aware of their importance in pregnancy and infant nutrition.

Generally it's the 20 and 22 carbon-chain long-chain fatty acids, eicosapentaenoic acid [EPA, 20:5(n-3)] and docosahexaenoic acid [DHA, 22:6 (n-3)] that have garnered the spotlight when it comes to omega-3 supplementation. The short 18 carbon-chain alpha linolenic acid [ALA, 18:3 (*n*–3)] from plants has been somewhat ignored. However, many less-publicized reviews reinforce ALA's unique and valuable potential in achieving a proper omega-3/omega-6 dietary balance.

According to Aliza Stark and Ram Reifen from the Hebrew University of Jerusalem and Michael Crawford from the Institute of Brain Chemistry and Human Nutrition at London Metropolitan University: "For many years, the importance of the only member of the omega-3 family considered to be essential, alpha-linolenic acid (ALA), has been overlooked."[3]

Clearly, ALA from vegetarian sources is different than EPA/DHA. They do not share all the same health benefits. However, not having the same health benefits does not mean lesser health benefits. It is important to recall that ALA is the parent molecule of the omega-3 fatty acids and greater understanding of its independent physiological function is important to the clinician and his or her patients.

Conversion of Omega-6 to Omega-3

ALA is derived from plant sources such as flax, pumpkin and chia seed, walnuts, wheat and barley grasses, leafy greens and avocados. EPA and DHA are derived from marine sources such as oily fish, krill and seals. Importantly, the bottom of the marine food-chain source of long-chain omega-DHA also is plant-based, coming from microalgae.

Much attention has been paid to the conversion of short-chain fatty acids to the longer-chain EPA/DHA, which according to Stark et al., is between eight and 20 percent of ALA being converted to EPA in humans, and between 0.5 and nine percent for conversion to DHA.[4] Generally, conversion is more efficient in women than men, likely related in part to the need of DHA in breast milk.

It should be noted that conversion of ALA to EPA is strongly linear, meaning the more ALA consumed the better the conversion.[5] Conversely, high omega-6, trans-fat, alcohol intake inhibits conversion of short-chain EFAs to long-chain EFAs, as do frank deficiencies in vitamins B_3, B_6 and C, and the minerals zinc and magnesium.[6]

Such conversion measurably contributes to the body's pool of EPA, as this 2006 study from the *Journal of Nutrition* shows.[7]

"We studied the effect of daily supplementation with 3 gm of ALA on the plasma concentration of long-chain (n-3) fatty acids in a predominantly African-American population with chronic illness. In a randomized, double-blind trial, 56 participants were given 3 gm ALA/d from flaxseed oil capsules or olive oil placebo capsules. Plasma EPA levels at 12 weeks in the flaxseed oil group increased by 60% ... whereas no change occurred in the olive oil group. Plasma DPA levels in the flaxseed oil group increased by 25% ... with no change in the olive oil group. Plasma DHA levels did not change in either group. This study demonstrates the efficacy of the conversion of ALA to EPA ... in a minority population with chronic disease."

It should be emphasized that although conversion of ALA to EPA was strong, the conversion of ALA to DHA was very weak. In any case, direct benefits such as improved vascular tone, heart rate, blood lipid levels, inflammatory responses and blood pressure, and reduced hardening of the arteries also have been associated specifically with ALA consumption.[8] These benefits might be in part due to a more favorable total omega-3 to omega-6 ratio.

Competition for the 6-desaturase conversion enzyme in the metabolism of both ALA and linoleic acid (LA) likely has an important role to play in these observed benefits. By increasing the intake of ALA, less of the 6-desaturase conversion enzyme is available to produce the pro-thrombotic, pro-inflammatory arachidonic acid (ARA) from LA. Conversely, metabolites of omega-3 origin are anti-inflammatory and anti-arrhythmic.[9] Therefore a greater intake of total omega-3, whether short- or long-chain, will decrease the omega-6 to omega-3 ratio closer to its 4:1 ideal and thereby, reduce pathogenic pathways of many diseases, including cardiovascular disease, cancer, osteoporosis, and inflammatory and autoimmune diseases.[10] This reduction of pathogenic pathways occurs more or less independent of the conversion rate of short-chain fatty acids to long chain fatty acids.

Dietary, Fortification and Supplemental Recommendations

Therefore, although Stark, et al. do not question the health benefits of EPA or DHA, they do call for more attention to be paid to total omega-3 nutritional intake and the ratio of omega-6 to omega-3 fatty acids in the diet. Interestingly, dietary recommendations currently exist for ALA, an essential fatty acid, but not EPA or DHA.

"The fact that several major scientific and medical associations have published nutritional guidelines including recommendations specifically for ALA emphasizes its perceived importance in health promotion and disease prevention," wrote Stark, et al.[11]

The American Dietary Association (ADA) recommends 500 mg/day EPA and DHA from fish or supplements. While it might seem logical to thereby just bypass the conversion problem, there are considerations. First, many people will not eat fish or take fish pills or oils. Indeed, the National Health and Nutrition Examination Survey, which dates back to 1999-2000, found that fish intake in the U.S. population is inadequate, with the mean intake of EPA and DHA being 100 mg/day![12]

High doses of fish oil can lead to bleeding disorders, even hemorrhagic stroke. High doses of DHA have been shown to inhibit elongases and desaturases, which in turn affect the metabolism of other n-3 and n-6 fatty acids.[13]

Fish higher up in the food chain tend to concentrate oceanic and freshwater pollutants. Furthermore, much of the world’s fish populations are in serious jeopardy of being overfished, even to the point of collapse, and such harvesting may not be sustainable.[14] Fish oils are pro-oxidants, requiring extra vitamin E intake, and

even worse, are often rancid.[15] Fortunately, there are companies going right to the source and gathering DHA from marine algae and supplying these as pills and as an ingredient in yogurt, orange juice, and most recently, in some plant-based omega-3 functional-food powder drink mixes.

Therefore, more and more authorities argue it's imperative that we increase our omega-3 nutrition and supplementation from sustainable, non-toxic plant sources while we cut back on the amount of omega-6s, trans-fat and avoid excess saturated fats.[16]

According to the ADA, when making a decision about how to include a target nutrient in the diet, it's imperative to consider the nutrient profile of a whole food as compared to a supplement. It states, for example, fish is an excellent source of protein, vitamins and minerals that are not present in EPA/DHA pills. Fish also competes with other high-saturated fat protein sources, leading to lower-saturated fat intake. By the same logic, supplementing the diet with omega-3, crushed whole-seed powders, especially flaxseed, as compared to flax oil supplements, also supplies an excellent source of vitamins, minerals, fiber, antioxidants and phytonutrients. As such, it also might concurrently help to displace high omega-6, trans-fat and high-glycemic foods. Fish and flax (the latter is by far the most common omega-3-rich food source) "bring to the table," as the ADA says, more than just n-3 fatty acids, but complete, nutrient-dense nutrition.

When it comes to vegan sources of omega-3 supplementation, it should be admitted that although ALA-rich flaxseed has many whole-food benefits and (likely by conversion) supports EPA status in most cases, the boosting of DHA is much more dubious. Therefore, combining flaxseed powders with vegan sources of marine DHA from microalgae makes for broader and more complete omega-3 supplementation. Also, considering the growing awareness of the importance of vitamin D and the endemic suboptimal vitamin D status of many Americans combined with the fact that fish is the richest source of vitamin D, strong consideration should be given to vitamin D_3 inclusion in vegan omega-3 supplements.

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