Food as medicine: the anti-inflammatory diet

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Introduction

It is widely agreed that chronic, low-grade inflammation is the root cause of many serious illnesses, ranging from heart disease[1–3] to some cancers[4–9] to depression,[10–12] and neuro-degenerative conditions including Alzheimer's[13–15] and Parkinson's diseases.[16, 17] The pathogenesis of these diverse illnesses may have a common root in activation of the inflammasome, the intracellular, multiprotein complexes that are central to innate immunity.[18] When activated, these molecular structures release cytokines that mediate the inflammatory response. In its place, inflammation is the cornerstone of the body's healing system, bringing added nourishment and immune activity to a site of infection or injury. But when inflammation persists beyond what is necessary for defense or repair or serves no purpose, it damages healthy tissues and illness may ensue.

Lifestyle factors such as psycho-social stress,[19] lack of exercise.[20, 21] and toxic environmental exposures[22, 24] can all contribute to excessive inflammation, but diet is a major influence. Research is beginning to demonstrate that certain dietary patterns and specific foods can impact the inflammasome. For example,

high-carbohydrate diets promote activation of the inflammasome, and fructose is a particular trigger for inflammation in the liver.[25, 26] Intermittent fasting and other forms of caloric restriction inhibit inflammasome activation,[27] as does curcumin, the most active component of turmeric.[28] Food choices are particularly important because we have – at least potentially – control over them.

There is no debate regarding the unhealthy nature of the typical Western diet, yet agreement on what constitutes a healthy diet remains surprisingly elusive. Contradictory messages about diet are pervasive, creating confusion and anxiety among patients. Healthcare professionals are usually of little help because their training in nutrition is inadequate. Learning how specific foods influence the inflammatory process is one of the best strategies to reduce overall disease risk and promote optimum health.

This article briefly outlines a practical approach to dietary modification that reduces the likelihood of chronic inflammation while emphasising variety, freshness, and pleasure from food. The discussion concentrates on key areas of consensus emerging from studies of diet and

health, not nutritional fads. This is the Anti-Inflammatory Diet (AID). The AID is best considered the nutritional component of an overall healthy lifestyle programme. It builds on traditional Mediterranean and Japanese eating patterns, whose anti-inflammatory and health-promoting effects are well-established,[29–34] especially with regard to primary and secondary prevention of cardio-vascular disease.[35–38]

Caloric intake

A balanced anti-inflammatory diet should include a reasonable number of calories to replace those lost in everyday life, as well as the right mix of healthy fats, carbohydrates and proteins to meet the body's nutritional needs. Each of the macronutrients affects the body's inflammatory status in unique ways. Caloric intake should range between 2000–3000 calories a day for most people, with 30% coming from fat, 20–30% from protein, and 40–50% from carbohydrates.

Macronutrients

Fats

Conventional medical wisdom suggests cutting back on saturated fat

intake as well as the total amount of fat eaten, but this is only part of the story. Although evidence for the health risks of saturated fat has been strong, new data has called some long-held beliefs into question.[39–41] Evidence for the health risks of total fat consumption is much less convincing. Chronic, low-grade inflammation can best be controlled from a dietary perspective by increasing the intake of anti-inflammatory fats while reducing or avoiding ingestion of fats known to promote inflammation.

The principal natural sources of saturated fat are beef, pork, lamb, unskinned chicken, duck, whole milk, products made from whole milk, and processed foods made with tropical oils (coconut and palm). The easiest to way to cut down on dietary saturated fat, as well as caloric intake (fat has almost twice as many calories per gram as protein and carbohydrate), is to lessen reliance on animal foods. Note that saturated fats are not equal with regard to cardio-vascular risk. It may be that fat in meat (beef especially) is particularly atherogenic, while dairy fat is least harmful and possibly beneficial.[42]

Although polyunsaturated cooking oils (corn, soy, sesame, sunflower, cottonseed, and safflower) lower LDL cholesterol and have been promoted for cardiovascular health, they are chemically unstable and readily react with oxygen, particularly in the presence of light and heat, resulting in toxic compounds that can damage DNA and cell membranes and promote inflammation. It is best to reduce consumption of polyunsaturated oils in favor of monounsaturated ones, although high-oleic versions of sunflower and safflower oil are closer in composition to olive oil and are acceptable options.

When unsaturated fatty acids are heated or treated with chemical solvents and bleaches, they tend to deform, going from their natural curved shape (cis-configuration) to an unnatural jointed shape (trans-configuration). The body builds cell membranes out of cis-fatty acids and also uses them in synthetic pathways for regulatory compounds that influence inflammation and cell proliferation. Trans-fatty acids, or TFAs, are widely regarded as toxic and pro-inflammatory.[43–45] They can be removed from the diet by excluding all margarines, solid vegetable shortening and products made with them, as well as all products listing 'partially hydrogenated' oil of any kind on the label and by avoiding most fried foods. It has been estimated that banning trans-fats could prevent 20,000 heart attacks and 7,000 deaths a year in the United States alone.[46]

Vegetable oils that are predominantly monounsaturated include olive, canola, peanut, and avocado oils. They may offer significant health benefits, especially in the case of olive oil, a prominent component of the Mediterranean diet. Extra-virgin olive oil is high in oleic acid and poly-phenols with significant anti-inflammatory and antioxidant properties.[47, 48] High-quality extra-virgin olive oil also contains a natural anti-inflammatory agent, oleocanthal, with activity comparable to that of ibuprofen.[49]

One of the most important dietary recommendations that doctors can make to their patients is to use extra-virgin olive oil as the main fat in food preparation.

The body synthesises prostaglandins and leukotrienes from essential polyunsaturated fatty acids (those that must be obtained from food). Humans require regular intake of both omega-3 and omega-6 essential fatty acids for optimum health. These differ in their chemical structure and their actions within the body. In general, hormones synthesised from omega-6 substrates upregulate inflammation, blood clotting, and cell proliferation. Those made from omega-3s have opposite effects. Omega-6s are widely available in seeds and the oils extracted from them and also build up in the fat of the grain-fed animals we eat. Unfortunately, the starting materials for the anti-inflammatory pathway, the omega-3s, are mainly found in oily fish and are harder to come by. The two omega-3 fatty acids critical to human health are eicosapentaenoic acid (EPA) and docosahexaenoic (DHA).

The ratio of omega-6 to omega-3 fatty acids in the diet is important for regulating the production of pro-inflammatory and anti-inflammatory compounds in the body.[50] Experts believe that ratio was about equal in the distant past. Today, most people in industrialised Western countries consume far more omega-6s than omega-3s. Reasons for this change include the flooding of today's diet with refined vegetable oils (especially soy oil), fattening food animals (especially cows) on grain, increased consumption of meat relative to fish, and decreased consumption of greens and other vegetable sources of omega-3s. Almost all snack foods (chips, crackers, cookies, and candy) and fast foods are high in omega-6 fatty acids and devoid of omega-3s. This imbalance is a major driver of unhealthy inflammation.

Oily fish from cold northern waters are the best omega-3 food source, as they concentrate EPA and DHA in fat. Good options include sardines, herring, mackerel, and wild salmon. Flax and hemp seeds are also high in omega-3s, as is the wild green, purslane, but they provide a precursor compound (ALA, alpha-linolenic acid), whose conversion to EPA and DHA is inefficient, especially in the context of high intake of omega-6s. Coldwater fish should be eaten 2 to 3 times a week to help keep inflammation in check. Fish oil supplements are available for those who do not enjoy eating fish, but they may not provide the same health benefits.[51]

Protein

The majority of people living in industrialised nations consume more protein than they need, which may be unhealthy, and the kinds of protein they eat may not be optimal. A remarkably small amount of protein is required to satisfy the minimal requirements of the average adult – perhaps two ounces of a protein food each day. One meal a day – organised around a main course of meat, chicken, fish, eggs or vegetable protein – is probably sufficient. When more protein is ingested than the body requires, it is used as an energy source. Protein digestion and metabolism is inefficient, however, requiring more energy than the digestion and metabolism of fats and carbohy-drates. In addition, protein is not a 'clean' fuel source.

Fats and carbohydrates burn to carbon dioxide and water, but protein metabolism leaves toxic nitrogenous residues that must be processed by the liver and kidneys.

The animal foods that most people rely on for protein are high in saturated fat. Being high on the food chain, they are more likely to accumulate environmental toxins, and, unless raised organically, carry residues of growth-promoting hormones, antibiotics, and other chemicals used by commercial farmers. 'White' meat is no better than red meat in this regard, except that veal has less fat than beef, and pork fat (lard) appears to be less athero-genic. Regularly eating processed meats, such as bacon, lunchmeats, and cured sausages, is associated with increased risks of cancer and all-cause mortality.[52, 53] Chicken offers at least one significant advantage: its fat is external to muscle tissue and can be removed with the skin. Otherwise, chicken and other poultry present the same toxic hazards as the flesh of cows, sheep, and pigs.

As noted earlier, scale fish are a good source of protein and omega-3 fats, but exposure to chemicals and pollutants that contaminate lakes, rivers and oceans makes larger, more carnivorous, and coastal fish less desirable as food. Swordfish, marlin, tilefish and shark, for example, are likely to contain high levels of mercury, PCBs, and other toxins.[54] Unless they are raised carefully, farmed fish may not be as beneficial to health as their wilder counterparts (farmed salmon have lower amounts of omega-3s) and may contain residues of drugs used in commercial fish farms. Even with these drawbacks, fish remains a good protein source. Shellfish are also good, but select molluscs carefully to avoid those that might be high in toxic contaminants.

Milk products tend to be high in saturated fat, unless they are made from skimmed or low-fat milk (which might not be as healthy as whole milk[55]). Many people cannot digest the sugar (lactose) in cow's milk products, and many more experience immune system irritation from one of its proteins (casein). Cow's milk in all forms can be especially problematic for people with gastrointestinal and atopic disorders and autoimmunity. Whole eggs in moder-ation are good additions to the diet; the whites are an excellent source of protein. Eggs fortified with omega-3s are now widely available.

Vegetable protein sources include beans and other legumes such as lentils and peas, grains, and some nuts. An important difference between animal and vegetable protein sources is that the latter are less concentrated. For example, the protein in beans is diluted by edible starch and indigestible fibre, so that a greater weight of beans must be eaten to get the equivalent protein derived from a similar portion of animal food. Vegetable protein has fewer toxic contaminants and a healthier fat profile, as well as beneficial phytonutrients. Soybeans contain more protein than other beans, along with significant amounts of polyunsaturated fat and phytoestrogens that may offer protection against hormonally-driven cancers in both women and men. Eating a small handful of nuts most days of the week has a markedly beneficial effect on

inflammation and risk of cardiovascular disease.[56, 57] Overall, it is a good idea to reduce consumption of meat in favour of vegetable protein.

Carbohydrates

It is important to learn the difference between quickly digested and slowly digested carbohydrate foods. That difference is measured on the glycemic index (GI) scale.[58] High-GI carbohydrates raise blood sugar quickly and significantly. Another measure, glycemic load (GL), factors in the actual amount of carbohydrate consumed in a portion of a specific food. Rapidly digested, high GI/GL foods are often highly processed and of low quality, such as fast foods, breads and other products made with flour; snack foods; and sweetened beverages. Eaten regularly, these contribute to insulin resistance, dysregulate blood sugar, and promote inflammation by favouring glycation reactions between blood sugar and proteins that result in pro-inflammatory end products.[59–62] Replacing foods made with flour with whole grains markedly reduces markers of inflammation.

High intake of vegetables and fruits has repeatedly been shown to reduce pro-inflammatory changes and to offer significant protection against cancer,[63] heart disease, and other serious ailments.[64] Vegetables are low in calories and high in micronutrients such as antioxidant vitamins and minerals and protective phytochemicals. Brightly colored produce of all hues, from leafy greens to carrots to berries, is rich in anti-inflammatory carotenoids, flavonoids, and anthocyanins. Fresh and frozen vegetables and fruits likely provide more health benefits than canned or dried versions, and organic varieties have lesser amounts of agrichemical residues than conventionally grown produce.[65]

Vegetables and fruits, together with whole grains and nuts, represent the primary source of dietary fibre. Adequate fibre intake helps reduce serum cholesterol levels, promotes digestive health, and reduces chronic inflammation, in part by decreasing lipid peroxidation.[66–69] Whole grains, such as rice, barley, quinoa, millet and wheat berries, also support a desirable gut microbiome that reduces inflammation both locally and systemically.[70]

Additional considerations

Dark chocolate (more than 70% cocoa) and red wine contain polyphenols, compounds that reduce inflammation and provide antioxidant protection.[71, 72] Both are best consumed in moderation. Tea, especially green tea, also contains polyphenols and together with clean water should be the beverage of choice.[73] Turmeric (Curcuma longa) is the most powerful natural anti-inflammatory agent.[74] Along with its botanical relative, ginger (Zingiber officinale),[75] it and other spices and herbs should be consumed frequently. Adding turmeric and ginger to favored recipes may increase both enjoyment and the health benefits of meals.

Bottom line

Healthcare professionals should be able to inform patients about an evidence-based dietary programme that helps mitigate inappropriate inflammation while not skimping on taste. Key directives of the AID are:

- eat the amount of calories needed to maintain normal weight

- keep saturated fat intake moderate by eating fewer foods of animal origin

- avoid trans fats by eschewing margarine, vegetable shortening, foods that contain partially hydrogenated oils, and most fried foods

- primarily use high-quality extra-virgin olive oil in the kitchen; do not cook with polyunsaturated vegetable oils

- eat oily, cold-water fish 2 to 3 times a week for their omega-3 fatty acids

- replace animal protein with fish and vegetable protein

- eat a variety of brightly colored vegetables and fruits every day, choosing organically grown produce when possible

- eat more whole grains and products made from them

- flavour foods with a variety of herbs and spices, especially turmeric and ginger

- include tea, dark chocolate, and red wine (in moderation) in the diet.

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