issues

by Dr. Diane H. Morris

Examining omega-3 nutrition

at **issue**: Is the dietary omega-6/omega-3 ratio important?

at **issue**: Do North Americans need higher intakes of omega-3 fatty acids?

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summary

at issue: Is the dietary omega-6/omega-3 ratio important?

The diet of humans living in the Paleolithic era was rich in omega-3 fatty acids, with a dietary ratio of omega-6 fatty acids to omega-3 fatty acids of about 1:1. Today's North American diet is high in omega-6 fats and low in omega-3 fats, giving a ratio between 10:1 and 16:1. Some nutrition experts believe the dietary omega-6/omega-3 ratio is a good tool for evaluating and predicting risk of heart disease. Other experts believe the ratio has little value in predicting heart disease risk. Regardless of which side prevails, consumers can benefit from consuming more omega-3 fats and fewer omega-6 fats.

at issue: Do North Americans need higher intakes of omega-3 fatty acids?

Current omega-3 fat intakes may not be optimum for preventing heart disease and other chronic diseases. For this reason, consumers are advised to consume more omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), found mainly in fatty fish and fish oil supplements. The importance of alpha-linolenic acid (ALA), the essential omega-3 fatty acid found mainly in plants like flax, walnuts, canola oil and soybean oil, is also recognized.

Given the growing concern that global fish stocks are not sustainable long term, some experts believe the time has come to focus on developing alternatives to fish and fish oil such as algae, yeast and plants designed to produce the omega-3 fats now obtained from fish. In a healthy diet, consumers still need a source of essential ALA. Increasing their ALA intakes can be achieved easily by adding ALA-rich foods such as milled flax, flax oil, canola oil or walnuts to their daily diets.

at issue: How do fish fare In terms of sustainability, safety and affordability?

Current intakes of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the long-chain omega-3 fatty acids found mainly in fatty fish, are about 100 to 200 mg/day. Achieving recommended higher intakes of 500 mg to 1 g of EPA + DHA daily will be challenging on several fronts. Any increase in consumers' fish intake is likely to place additional pressures on North American and global fish stocks, many of which are overfished. In addition, concerns about the contamination of fish with methylmercury, dioxins, pesticides and other chemicals have led to federal advisories in both Canada and the United States. Finally, many low-income and middle-class families may not be able to afford to buy fatty fish, the main source of EPA and DHA.

Compared with seafood, plant-based sources of the essential omega-3 fatty acid alpha-linolenic acid (ALA) are a sustainable, renewable and relatively inexpensive source of essential omega-3 fat. Many consumers may find it easier, more convenient and more environmentally friendly to add a little ground flax or flax oil to the diet than to learn to cook or enjoy the taste of fatty fish.

at issue: How healthy are populations that rely on plants as sources of omega-3 fatty acids?

Many federal health agencies advise consumers to eat seafood to obtain eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the long-chain omega-3 fatty acids found mainly in fatty fish. Not everyone eats fish, however, and the question arises: How healthy are people who do not eat fish or take fish oil supplements, but rely instead on plants as a source of alpha-linolenic acid (ALA), the essential omega-3 fatty acid?
The answer: remarkably healthy.

Full-term infants, for example, obtain an adequate amount of omega-3 fatty acids, including DHA, for brain development from breast milk or enriched infant formula. Furthermore, full-term infants born to vegan and vegetarian women, who typically have low DHA intakes, appear to develop normally and do not exhibit deficits in brain development. Adult vegans and vegetarians, who obtain most or all of their omega-3 fats in the form of ALA-rich plants, are remarkably healthy and have low rates of heart disease and some types of cancer. Plus, plant-based diets are more environmentally friendly, contributing less to green-house gases and requiring fewer energy inputs than meat-based diets.

Introduction

As a class of nutrients, omega-3 fatty acids are widely valued for their health benefits and their role in reducing the risk of chronic diseases like heart disease, stroke, cancer and diabetes. As individual fatty acids, however, few nutrients seem to engender as much scientific controversy. This document examines several questions that often arise in any discussion of omega-3 fatty acids. The main omega-3 fatty acids considered are alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). ALA is the true essential omega-3 fatty acid, being required in the human diet because our bodies do not make it.

Omega-3 fatty acids at a glance

Alpha-linolenic acid (ALA) – the true essential omega-3 fatty acid found mainly in plants such as flax, canola oil, soybean oil, walnuts, green leafy vegetables like spinach, and also in meat, poultry, eggs (both regular and omega-3-enriched) and seafood.

Docosahexaenoic acid (DHA) – a long-chain omega-3 fatty acid found mainly in fatty fish, fish oil supplements and omega-3-enriched eggs.

Eicosapentaenoic acid (EPA) – a long-chain omega-3 fatty acid found mainly in fatty fish, fish oil supplements and omega-3-enriched eggs.

Essential fatty acids (EFA) – ALA is the true essential omega-3 fatty acid, being required in our diets because our bodies do not make it; the other omega-3 fatty acids like EPA and DHA are not “essential” in the strictest sense because our bodies make them from dietary ALA and tissue stores of ALA. Nonetheless, all omega-3 fatty acids – including ALA, EPA and DHA – are often called “essential fatty acids” because their importance in human nutrition and health is widely recognized.

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Is the dietary omega-6/omega-3 ratio important?

The diet of humans living in the Paleolithic era was rich in omega-3 fatty acids, with a dietary ratio of omega-6 fatty acids to omega-3 fatty acids of about 1:1. Today's North American diet is high in omega-6 fats and low in omega-3 fats, giving a ratio between 10:1 and 16:1. Some nutrition experts believe the dietary omega-6/omega-3 ratio is a good tool for evaluating and predicting risk of heart disease. Other experts believe the ratio has little value in predicting heart disease risk. Regardless of which side prevails, consumers can benefit from consuming more omega-3 fats and fewer omega-6 fats.

A debate is underway over the importance of balancing omega-6 fatty acids and omega-3 fatty acids in the diet – usually referred to as the omega-6/omega-3 ratio or the n-6/n-3 ratio. On one side are those who believe the n-6/n-3 ratio is a major determinant of risk for heart disease and possibly other chronic diseases. Their argument is founded on evidence from the Paleolithic era, which covers the time period when our current genetic profile was established between 2.5 million and 10,000 years ago. The diet of Paleolithic humans was rich in omega-3 fats, particularly ALA found in wild plants, nuts, berries and the meat of wild animals.[1] Paleolithic humans had an n-6/n-3 ratio of roughly 1:1.[2]

Omega-6 fatty acids belong to an entirely different family of fatty acids than the omega-3 fatty acids. The main omega-6 fatty acid in the diet is linoleic acid, which is the essential omega-6 fatty acid, being required in the diet because our bodies do not make it. The main dietary sources of omega-6 fatty acids are vegetable oils like sunflower oil, corn oil and soybean oil and food products made with these oils.

Today in North America, the n-6/n-3 ratio is between 10:1 and 16:1. The high n-6/n-3 ratio of today's typical Western diet reflects our much greater intake of omega-6 fatty acids compared with omega-3 fatty acids, due mainly to the increased consumption over the past 150 years of omega-6-rich vegetable oils such as corn, soybean and sunflower oils.[2,3] A high dietary n-6/n-3 ratio is associated with higher concentrations of compounds that cause inflammation and greater aggregation or clumping of platelets in the blood – both factors that increase the risk of heart disease.[4,5] A high dietary n-6/n-3 ratio has also been linked with an increased risk of dry eye syndrome in women[6] and a higher risk of breast cancer in premenopausal women.[7]

On the other side are those who believe the dietary n-6/n-3 ratio is of little value in predicting disease risk, at least where heart disease is concerned. These experts believe that what happens within the body is more important than the ratio of fatty acids in the diet.[8,9] In two clinical studies, the dietary n-6/n-3 ratio was not related to high blood cholesterol levels[10] or to measures of insulin resistance, which is associated with increased risk of ischemic heart disease.[11] (High blood cholesterol is a risk factor for coronary heart disease.)

Conclusion

Future research will ultimately determine which side prevails. In the meantime, the consensus is strong: North Americans can benefit from decreasing their intake of omega-6 fats and increasing their intakes of omega-3 fats, including ALA.

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Do North Americans need higher intakes of omega-3 fatty acids?

Current omega-3 fat intakes may not be optimum for preventing heart disease and other chronic diseases. For this reason, consumers are advised to consume more omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), found mainly in fatty fish and fish oil supplements. The importance of alpha-linolenic acid (ALA), the essential omega-3 fatty acid found mainly in plants like flax, walnuts, canola oil and soybean oil, is also recognized.

Given the growing concern that global fish stocks are not sustainable long term, some experts believe the time has come to focus on developing alternatives to fish and fish oil such as algae, yeast and plants designed to produce the omega-3 fats now obtained from fish. In a healthy diet, consumers need a source of essential ALA. Increasing their ALA intakes can be achieved easily by adding ALA-rich foods such as milled flax, flax oil, canola oil or walnuts to their daily diets.

The current North American dietary recommendations for omega-3 fatty acids are set to achieve an intake that prevents an omega-3 fatty acid deficiency. Some experts question whether current North American intakes of alpha-linolenic acid (ALA) and the other omega-3 fatty acids are optimal, and, if they are not, how consumers can best achieve higher intakes of omega-3 fatty acids.

Current intakes of omega-3 fatty acids may not be optimal

North Americans consume on average about 1.5 g or 1500 mg of ALA per day – more than enough to prevent deficiency symptoms. They also consume about 0.1 to 0.2 g or 100 to 200 mg of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) per day.[1,2]

Some experts, however, recommend higher intakes of all omega-3 fatty acids, based on clinical evidence showing that omega-3 fats help reduce inflammatory reactions, promote the health of blood vessels and reduce the risk of heart attack, stroke and other chronic diseases.[3] Higher ALA intakes of 2.2 g to 3 g per day have been proposed. An intake of 500 mg of EPA + DHA daily has been recommended to reduce risk of heart disease. For people with existing heart disease, an intake of 1 g (1000 mg) of EPA + DHA daily is recommended.[4,5]

Some national health agencies and health organizations in Canada, the European Union, Japan, Mexico and the United States advise consumers to eat at least two servings of fish weekly to obtain EPA + DHA[5-8] or recognize the importance of fish and omega-3 fatty acids in a healthy diet.[9,10] The American Heart Association specifically advises consumers to consume vegetable oils as a source of ALA.[5]

Achieving a higher intake of ALA

Achieving an ALA intake as high as 3 g/day is not difficult, requiring a rough doubling of an adult's usual intake. Increasing the ALA intake from the current intake of about 1.5 g/day to the higher recommended intake of 3 g/day requires adding to the daily diet only 1 tbsp of milled flax, less than 1 tsp of flax oil, a generous tbsp of canola oil or a little more than ½ oz of walnuts.

Achieving higher intakes of EPA and DHA

Higher intakes of EPA + DHA can be achieved by eating more seafood, taking fish oil supplements and/or eating more ALA-rich plants. The issue of how best to obtain more dietary EPA + DHA offers some challenges for policy makers, the food industry and consumers alike, as outlined below.

Daily dose of seafood. A considerable amount of seafood must be eaten daily to achieve the recommended intakes of EPA + DHA of either 500 mg/day or 1 g/day. Table 1 lists the number of servings needed to increase EPA + DHA intakes, using nutrient data on the most popular seafood eaten in the United States.[11,12] With the exception of salmon, at least one serving of the seafood shown in the table must be eaten every day to obtain the recommended intake of 500 mg EPA + DHA/day to reduce heart disease risk. People with existing heart disease must eat between two and eight daily servings of seafood to achieve the recommended intake of 1 g EPA + DHA/day.

A daily intake between 500 mg and 1 g is 2 to 10 times the typical EPA + DHA intake of North Americans. Achieving these higher intakes means that consumers must eat more fish, thus increasing pressures on already fragile global fish stocks.[13] Some experts believe the

time has come for policy makers and national health agencies and organizations to refrain from advising consumers to eat more fish.[14]

TABLE 1

Number of servings of seafood needed to meet increased dietary recommendations for omega-3 fatty acids

Fish and Shellfish[a]	serving size	number of servings to get 500 mg EPA+DHA/day from seafood[b]	number of servings to get 1 g EPA+DHA/day from seafood[b]
shrimp, breaded and fried	**3 oz**	**2 ½**	**5**
canned tuna, light, in water	**3 oz**	**2**	**4**
salmon, farmed, cooked, dry heat	**3 oz**	**~ ⅓**	**<1**
pollock, cooked, dry heat	**3 oz**	**~1**	**2**
catfish, breaded and fried	**3 oz**	**1 ½**	**3**
tilapia, cooked, dry heat	**3 oz**	**4**	**8**
crab, cooked, moist heat	**3 oz**	**1**	**2 ½**
cod, cooked, dry heat	**3 oz**	**3 ½**	**7 ½**

[a]Listed in order of U.S. per capita consumption in 2004 (11).
[b]The number of servings is a rough estimate because the oil content of seafood varies substantially by species, diet, season of the year, type of packaging and method of preparation. Nutrient data for the serving calculations were obtained from the U.S. Department of Agriculture (12).

Daily dose of fish oil supplements. For people who do not like the taste of fatty fish such as mackerel and herring, an option is to take fish oil supplements. Fish oil capsules provide 180-650 mg of EPA and 120-300 mg of DHA per 1000 mg capsule or dose. Depending on the formulation, up to three capsules must be taken daily to achieve an intake of 1 g of EPA + DHA/day. This option is convenient for some consumers, although compliance with a daily regime of capsules can be a problem due to palatability and cost. Large doses of fish oil may have adverse side effects.[15]

Daily dose of ALA-rich foods. The human body converts ALA to the long-chained omega-3 fatty acids – mainly EPA and also DHA in small amounts.[16] About 3.6 g of dietary ALA can be converted by the body to 500-540 mg of long-chain omega-3 fatty acids.[17,18] The option to increase ALA intake – and, hence, the amount of ALA available in the body for conversion to EPA and DHA – is fairly easy for consumers, requiring the addition of ALA-rich foods like flax, canola oil and walnuts to their daily diets. Food companies can reformulate their food products to provide a greater variety of ALA- and omega-3-enriched foods, while consumers can be encouraged to choose such products and eat more ALA-rich plants.

Conclusion

Although North Americans stand to benefit from consuming more omega-3 fats, dietary recommendations do not consider whether the main sources of some of them – namely, fatty fish and fish oil supplements – are sustainable long term. Since many global fish stocks are currently overfished,[13] some experts believe the time has come to develop alternatives to fish and fish oil such as single-cell organisms and plants modified to produce ALA, EPA and DHA.[14] Today's consumers may find it easier, more convenient and more environmentally friendly to use milled flax or flax oil as a source of essential omega-3 fat in the diet. Tomorrow's consumers may look, not to the oceans, but to novel sustainable and renewable sources of essential omega-3 fats.[14]

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How do fish fare in terms of sustainability, safety and affordability?

Current North American intakes of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the long-chain omega-3 fatty acids found mainly in fatty fish, are about 100 to 200 mg/day. Achieving recommended higher intakes of 500 mg to 1 g of EPA + DHA daily will be challenging on several fronts. Any increase in consumers' fish intake is likely to place additional pressures on North American and global fish stocks, many of which are overfished. In addition, concerns about the contamination of fish with methylmercury, dioxins, pesticides and other chemicals have led to federal advisories in both Canada and the United States. Finally, many low-income and middle-class families may not be able to afford to buy fatty fish, the main source of EPA + DHA.

Compared with seafood, plant-based sources of the essential omega-3 fatty acid alpha-linolenic acid (ALA) are a sustainable, renewable and relatively inexpensive source of essential omega-3 fat. Many consumers may find it easier, more convenient and more environmentally friendly to add a little ground flax or flax oil to the diet than to learn to cook or enjoy the taste of fatty fish.

Fish and shellfish are widely valued for their healthy fat profile, high-quality protein, and vitamins and minerals.[1] Even so, there are serious concerns about the long-term sustainability of fish stocks and the safety and affordability of seafood.

Sustainability of fish stocks

In 2006, the latest year for which data are available, 80% of the world's wild fish stocks were reported as fully exploited or overexploited, leading the Food and Agriculture Organization to conclude that the maximum potential for wild fisheries in the world's oceans has probably been reached.[2] Furthermore, commercial fishing over the past half-century has seriously depleted the biomass of the topmost fish in aquatic food chains.[3,4]

The Northwest Atlantic, the Western Indian Ocean and the Northwest Pacific are the areas showing the highest proportions of fully-exploited stocks.[2] Indeed, a report released in December 2008 by the U.S. National Marine Fisheries Service identified the following species as being overfished: Atlantic cod, Atlantic halibut, haddock, flounder, black sea bass, red snapper, bluefin tuna and Atlantic salmon.[5,6]

Safety of fish and fish oil supplements

Contamination of fish and fish oil with chemicals and heavy metals is a growing concern, as some of these pollutants are toxic to the nervous system or cause cancer. Moreover, the issue of seafood contamination is not likely to disappear, as water pollution occurs as a by-product of agriculture, transportation, manufacturing and industrial processes. In the Great Lakes region, for example, the number of "zero consumption" fish advisories increased between 2005 and 2007,[7] indicating increased water pollution in an area where efforts are being made to reduce pollution emissions.

Mercury contamination. Evidence of the contamination of seafood with methylmercury, a toxic metal that accumulates in the muscles of all fish,[8] led Canadian and U.S. federal health agencies to issue an advisory, which is still in effect, for women who might become pregnant, for women who are pregnant, for nursing mothers and for young children. Health Canada advises these groups to limit their consumption of fresh and frozen tuna, shark, swordfish, marlin, orange roughy and escolar.[9] The U.S. Food and Drug Administration advises these populations to avoid eating shark, swordfish, King mackerel or tilefish because these fish contain high levels of mercury. King mackerel is a major source of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the long-chain omega-3 fatty acids found mainly in fatty fish and fish oil. Salmon is low in mercury.[10]

Other contaminants. Even though salmon is low in mercury,[10] farm-raised salmon contains higher levels of polychlorinated biphenyls (PCBs), dioxin and some pesticides than wild salmon.[11] A risk-benefit analysis found that consuming the recommended intake of 1 g of EPA + DHA/day, proposed by the American Heart Association for people with diagnosed heart disease,

cannot be achieved solely from farmed or wild salmon while maintaining an acceptable level of cancer risk.[12] In addition, the purity of fish oil supplements is not regulated by federal health agencies.[13] Consumers must check with the supplement manufacturer to confirm that environmental contaminants found naturally in fish oil have been removed.

Affordability of fish versus plants

Low-income or even middle-class families may not be able to afford to buy fatty fish, the main source of EPA and DHA. Some sample costs of omega-3-containing foods are:

- A single 4-oz serving of **smoked salmon** or **salmon fillet** costs between $5.00 and $8.00, depending upon the region and supermarket.
- A 2 ½-lb bag of **milled flax** (roughly 1,134 g or 142 servings) can be purchased on the Internet for $10.00, giving a per-serving cost of $0.07.
- A bottle of **flax oil** can be purchased on the Internet for $10.24 (24 servings), giving a per-serving cost of $0.43.

The cost of one salmon fillet is about 70 times greater than the cost of one serving of milled flax. A recommendation to consume 1-2 tbsp of ground flax, flax oil or canola oil daily will substantially increase the intake of alpha-linolenic acid (ALA) and the proportion of adults who comply with the recommended ALA intake,[14] with a minimal effect on a household's budget.

Conclusion

Experts generally agree that most North Americans stand to benefit from consuming more omega-3 fats, and they recommend obtaining them from fatty fish or fish oil supplements. Many consumers, however, may not find this recommendation practical for reasons of taste, cost and concerns about fish contamination. In the long-term, choosing fish or fish oil supplements may not be sustainable, given current pressures on global fish stocks.[15] Compared with seafood, plant-based sources of ALA are a sustainable, renewable and relatively inexpensive source of essential omega-3 fat. Many consumers may find it easier, more convenient and more environmentally friendly to add a little milled flax or flax oil to the diet than to learn to cook or enjoy the taste of fatty fish.

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by Dr. Diane H. Morris

at issue

How healthy are populations that rely on plants as sources of omega-3 fatty acids?

Many federal health agencies advise consumers to eat seafood to obtain eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), the long-chain omega-3 fatty acids found mainly in fatty fish. Not everyone eats fish, however, and the question arises: How healthy are people who do not eat fish or take fish oil supplements, but rely instead on plants as a source of alpha-linolenic acid (ALA), the essential omega-3 fatty acid? The answer: remarkably healthy.

Full-term infants, for example, obtain an adequate amount of omega-3 fatty acids, including DHA, for brain development from breast milk or enriched infant formula. Furthermore, full-term infants born to vegan and vegetarian women, who typically have low DHA intakes, appear to develop normally and do not exhibit deficits in brain development. Adult vegans and vegetarians, who obtain most or all of their omega-3 fats in the form of ALA-rich plants, are remarkably healthy and have low rates of heart disease and some types of cancer.

Despite concerns about the contamination of some popular seafood with heavy metals, pesticides and the like, the nutritional benefits of diets containing seafood and fish oil are widely recognized.[1] Seafood and fish oil, for example, are the main sources of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), two long-chain omega-3 fatty acids. However, not everyone eats fish, and the question arises: How healthy are people who do not eat fish or take fish oil supplements, but rely instead on plants as a source of alpha-linolenic acid (ALA), the essential omega-3 fatty acid? The answer: remarkably healthy.

Breast-fed infants

Infants must rely on breast milk or formula for all of their nutrient needs. In the case of omega-3 fats, DHA is vital to their growth and development, being the most abundant fatty acid in the brain. Before birth, DHA is transferred across the placenta from the mother to the developing fetus; after birth, the infant obtains DHA from breast milk or enriched infant formula, from its own DHA stores and from ALA conversion to DHA.[2]

The notion that brain DHA content is sensitive to dietary DHA intake is not supported by evidence from breast-feeding populations: breast milk supplies an adequate amount of omega-3 fatty acids, including DHA, for brain development. In addition, the notion that only fish-based diets are sufficient for brain development is not supported by evidence from healthy populations consuming a land-based diet. Infants have mechanisms for coping with diet variations in DHA intake, even when ALA-rich plants are the main source of omega-3 fatty acids.[3] Full-term infants born to vegan and vegetarian women, who typically have low DHA intakes, appear to develop normally and do not exhibit deficits in brain development.[2,4] Preterm infants are an exception – they have special dietary needs, including a greater need for all essential fatty acids.[5,6]

Vegans and vegetarians

Vegans and vegetarians who live in affluent countries are remarkably healthy, having low rates of obesity,[7] coronary heart disease,[8] high blood pressure[9] and some types of cancer.[9-11] They also tend to have more desirable blood lipid and blood glucose levels[12] and to live longer than the general population.[10]

Their good health status is due partly to diet, which contains an abundance of plant foods rich in vitamins, minerals, antioxidants and dietary fibre while being low in saturated fat and cholesterol, and partly to adopting a lifestyle that involves being physically active and not smoking. Their good health is achieved despite relying almost exclusively on ALA-rich plants as a source of omega-3 fat and having low intakes of EPA + DHA. Furthermore, compared with meat and fish eaters, vegetarians are less exposed to environmental pollutants such as polychlorinated biphenyls (PCBs), methylmercury and lead.[13]

Environmental benefits of plant-based diets

Plant foods processed and transported in an energy-efficient manner produce fewer green-house gases and thereby contribute less to global warming than animal foods such as cooked eggs, chicken, pork, cheese and beef. An exception is the emission load of tropical fruits shipped long distances by air, which contribute roughly the same amount as the production of domestic cheese.[16] Vegetarian diets are also more environmentally friendly. Consumption of a meat-based diet uses 2.9 times more water, 2.5 times more primary energy, 13 times more fertilizer and 1.4 times more pesticides than a vegetarian diet.[17] In the future, dietary guidelines for North Americans may consider both the positive health and environmental aspects of vegetarian diets.

Conclusion

Infants obtain omega-3 fats, including ALA and DHA, from breast milk or enriched infant formula and from their own ability to make small amounts of DHA from ALA. There is no evidence that full-term infants born to vegan or vegetarian mothers fail to thrive and grow. Vegans and vegetarians obtain ALA almost exclusively from plant foods and they make small amounts of DHA from dietary and tissue stores of ALA. These groups appear to be healthy – indeed, vegans and vegetarians enjoy remarkably good health – even though they do not eat fish or take fish oil supplements. This suggests that dietary ALA provides sufficient EPA and DHA to maintain health in well-nourished populations.

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