HEALTH BENEFITS OF KRILL OIL

Krill Oil, which is naturally rich in Omega-3 phospholipids, has been demonstrated to give a substantially greater reduction of fat in the heart and liver than Omega-3 from fish oil.

Krill Oil reduced the fat content in the heart by 42%, fish oil only reduced the fat content by 2%. The corresponding examination of the fat amount in the liver showed a reduction of 60% after administration of Krill Oil, while fish oil only reduced the fat content in the liver by 38%. This can lead to a reduced insulin sensitivity and contribute to the development of type 2 diabetes.

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NUTRIGOLD™ LIMITED

Leading the way in nutritional technology

Contents

1 Health Benefits of Krill Oil

The Newsletter delivers a very exciting message for all those who wish to use nutritional supplements for health benefits. KRILL OIL has shot up to the number 1 position for supplying the crucially essential Omega-3 fatty acids. Firstly, it delivers Omega-3 in the same forms that are present in fish and fish oil (i.e. the long-chain forms, EPA and DHA), but without any fears about toxic contamination. This is due to the very low toxicity levels of the Antarctic Ocean. Secondly, the harvesting of krill from the sea is at a very low level compared with the huge stocks available and hence there is believed to be almost no environmental impact. Thirdly, this oil also contains significant amounts of phospholipid, giving you the effect of taking a phospholipid supplement as well, like lecithin, on an all-in-one basis. Moreover, this is marine phospholipid that has long-chain Omega-3 fatty acids built into it, unlike the Omega-6-rich oilseeds from land plants that are usually used to provide lecithin. Hence this phospholipid does not require to be broken down and re-synthesised but can be incorporated straight into the cell membranes of our bodies. This makes the marine phospholipid distinctly superior to land-based phospholipids. Fourthly, the Omega-3 and the marine phospholipid are accompanied by a supremely powerful antioxidant that surpasses most other antioxidants in its far-reaching effects, also on a wonderful all-in-one basis. Hence, with Krill Oil you can purchase just one supplement and yet have the full benefits of three of the most health-protective supplements available.
We shall discuss below the nature of krill. Then, as the Omega-3 Fatty Acids are at the core of successful lipid nutrition, we shall discuss these.

Krill Oil has been demonstrated to reduce the fat content of the heart twenty times more effectively than traditional fish oil.

The harvesting of krill from the sea is at a very low level compared with the huge stocks available and hence there is believed to be almost no environmental impact.

2 The Antarctic Krill – (Euphausia Superba)

These are small shrimp-like invertebrates living in the Antarctic waters of the Southern Ocean. They are found in densely packed swarms with as many as 10,000–30,000 individual animals per cubic meter. The larger specimens may be up to 6 cm long and weigh 20g. They feed directly on the phytoplankton, tiny plants that possess chlorophyll and they are therefore harvesting the “primary production energy” of the planet, i.e. energy very recently derived from sunlight (Ishii 1987). The gut can often be seen shining green through the animal's transparent skin, due to the high chlorophyll content of the diet. They are a key species in the Antartic ecosystem. It is estimated that there are 500 million tonnes of them in the Antarctic Ocean. Females lay 6,000–10,000 eggs at one time. The main spawning season of Antarctic krill is from January to March.

It is reported that the eggs descend from near the surface to depths of around 2,000–3,000m and then re-ascend while the first two larval stages occur. This is followed by two more larval stages at depths of about 60 m (Hempel & Hempel 1986).

Antarctic krill has the special ability to directly utilize the minute phytoplankton by filter-feeding (Hempel 1985). This is achieved by using the highly developed front legs as an efficient filtering apparatus or “basket” (Kils 2006). The algae are combed to the mouth opening with special bristles on the inner side of six specialized legs. Antarctic krill can also scrape off the green “lawn” of ice-algae from the underside of the pack ice. The krill’s waste sinks to the bottom of the sea, some 2,000–4,000m down. These contain significant amounts of carbon derived from atmospheric carbon dioxide: this process exports large quantities of carbon from the biosphere and sequesters it for about 1,000 years. In this way they must be helping to limit the extent of global warming. Still more research is needed to quantify the Southern Ocean ecosystem. The Southern Ocean covers 32 million square kilometres, or about 65 times the size of the North Sea.

Krill are often referred to as light-shrimp because they can emit light, produced by bioluminescent organs. Krill use an escape reaction to evade predators, swimming backwards very quickly at about 60 cm/second (Mauchline & Fisher 1969).

Antarctic krill is the keystone species of the Antartic ecosystem, and provides an important food source for whales, seals, leopard seals, fur seals, crabeater seals, squid, icefish, penguins, albatrosses, and many other species of birds.

Euphausia superba is confined to the Southern Ocean and other species are dominant in the Pacific.

Antarctic krill, especially in the early stages of development, seem to need the pack ice structures in order to have a fair chance of survival. The pack ice provides natural cave-like features which the krill use to evade their predators.

3 The Composition of Krill Oil

100g of Krill Oil normally delivers not less than 30g of Omega-3 fatty acids of which not less than 15g is present as EPA (see below) and not less than 9g is present as DHA (see below). This compares with typical or average fish oil that contains some 36g of Omega-3 per 100g. One has to expect that the krill oil will contain slightly less on a percentage basis due to the presence of other good ingredients, particularly the phospholipids, that add their own extra weight to the product. The phospholipids are mostly in the form of phosphatidyl choline (i.e. phospholipids in which the nitrogen base is choline). There are also smaller amounts of phospholipids in which the nitrogen base is ethanolamine (phosphatidyl ethanolamine) or inositol (phosphatidyl inositol). The total phospholipids per 100g of krill oil is not less than 40g, which is a very good titre.
Among the fatty acids present there is not more than 30g per 100g that are saturated, more than 12g are monounsaturated and more than 32g are polyunsaturated. Of these more than 30g are Omega-3 and typically approximately 2g (1.5g – 2.5g) are Omega-6.

Of the Krill Oil's other valuable constituents, there is more than 150mg/g of Esterfied Astaxanthin, 100 IU/g of trans Retinol (Vitamin A), 0.5 IU/g of alpha-Tocopherol (Vitamin E), 10 IU/g of Cholecalciferol (Vitamin D) and 30mcg/g of Selenium.

This represents an oil of outstandingly sound composition as a nutritional supplement oil, as we shall describe in full detail below.

4 Historical Recognition of Essential Fatty Acids

Fats taken in the diet are used in the body for energy, but since energy can also be supplied as protein and carbohydrate, fat for this purpose alone would not be essential. Nonetheless, in 1929 it was discovered that a deficiency disease developed in rats fed upon a diet that excluded fat (Burr & Burr 1929, 1930). The animals showed lack of normal weight gain and various skin conditions including scaliness of the feet and tail, dermatitis and dandruff. Subsequently this work was progressed further by Deuel and co-workers (1951) and Greenburg et al (1951). Linoleic acid was the first fatty acid demonstrated to have essential fatty acid activity.

Only later was it discovered that the two forms, Omega-3 and Omega-6, are separately and independently essential, having discrete functions in the body.

5 Which Supplementary Fatty Acids should one take?

We offer opposite a tabular summary of the different kinds of fatty acids that are nutritionally important. This gives an initial concise insight and can also be used for reference purposes.

Krill oil has been demonstrated to reduce the fat content of the liver by 50% more than traditionally used fish oil.

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Fatty Acid Type	Common Examples	Major Sources	Health Role
Saturated: Not Essential.	Palmitic Acid, Stearic Acid.	Animal fats and some particular plant fats.	Provide energy but too much of them may have negative effects.
Monounsaturated or Omega-9: Not Essential.	Oleic Acid.	Olive oil in particular but is present in many plant oils.	Probably positive because health benefits can be seen from diets rich in olive oil. However this may be due to other ingredients in the olive oil apart from Omega-9 fatty acids.
Polyunsaturated fatty acids of the type Omega-6: Essential.	Linoleic Acid, Palmitoleic Acid.	Many plant oils of commerce such as safflower, sunflower, soya, maize, groundnut oil. These oils are widely used in western diets today.	Absolutely essential to health. Deficiency leads to malfunctions. However, modern diets are often too high in Omega-6, leading to an imbalance between Omega-6 and Omega-3 that may impair some functions.
Polyunsaturated fatty acids of the type Omega-3: Essential.	Alpha-linolenic Acid, Eicosapentaenoic Acid (EPA) and Docosahexenoic Acid (DHA).	Flaxseed oil for alpha-linolenic acid: this is used mainly as a food supplement. Fatty fish for EPA and DHA. These two sources (flaxseed oil and fish) are not identical but in most people the use of either of these shows similar benefits.	Absolutely essential to health. Deficiency leads to malfunctions. Modern diets that do not contain ample oily fish are often too low in Omega-3, leading to an imbalance between Omega-6 and Omega-3 that may impair some functions.
Special Polyunsaturated fatty acids of the type Omega-6: Not Essential if other Omega-3s are available.	Gamma-linolenic Acid.	Evening Primrose Oil, Oil of Borage.	A very special form of Omega-6 that may still be needed even when there is adequate linoleic acid in the diet.
Phospholipids: Not Essential but often bring benefit.	Phosphatidyl Choline.	Concentrated from soya-bean lecithin.	A powerful liver-related, artery-related, blood pressure-related and cholesterol-related nutrient.
Mono- and Diglycerides: Not Essential.	Glyceryl monostearate.	Intermediates in fat digestion.	Important as emulsifiers.

We shall now examine these groups and comment upon their disease-prevention role and their physiological functions.

Before we do so we should note again that both the Omega-6 and the Omega-3 types are both separately essential. Therefore you can never make up for deficiency of one by taking more of the other. One reason why they are essential is that they act as precursor substances for a large group of chemical messenger substances within the tissues. These are the "eicosanoid" hormones. The subgroups of these include the prostaglandins, the thromboxanes and the leukotrienes (Horrobin 1983). There are many members of each of these three subgroups and they have diverse roles in controlling cellular and tissue behaviour. The Omega-6 and the Omega-3 types are independently and separately essential partly because they act as precursors to different members of these subgroups. The body requires all of these tissue hormones, i.e. those derived from both Omega-6 and Omega-3. This makes it very important that the diet should supply both Omega-6 and the Omega-3 types and it should supply them in amounts more or less in balance with each other and with the body requirements (Hanson 1983).

A second major effect of the Omega oils is that, after being incorporated into phospholipids, they influence the health and function of cell membranes. They affect the fluidity and permeability of the membranes, thereby influencing cellular health at a quite fundamental level.

6 Different Types of Omega Fatty Acids

Linoleic Acid (LA, Omega-6)

Symptoms seen in humans as a result of deficiency of Omega-6 fatty acids such as LA (or conditions that are helped by administration of extra LA) include alopecia, arthritis, behavioural disturbances, cardiovascular disease, eczema, lack of growth, liver degeneration, infections, kidney degeneration, miscarriages, sterility, thirst and poor healing of wounds. The range of physiological functions carried out by the eicosanoids that derive from Omega-6 is very extensive and very important. Ultimately these provide the mechanism by which the deficiency leads to the various symptoms. We do not provide all the details of these for reasons of space and because LA is commonly provided in sufficient amount in UK, European and N. American diets.

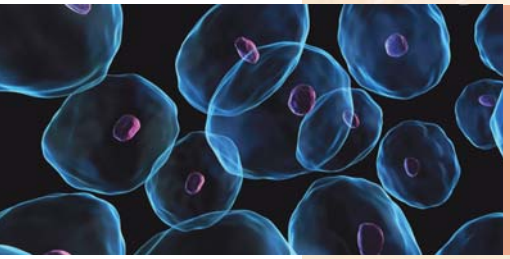
Alpha-Linoleic Acid (ALA, Omega-3)

The Omega–3 class is by far the scarcer of the two in the modern Western diet and the only concentrated source in most people's diet is fish, though ALA is not the main fatty acid that fish contains. Non-fish eaters, including strict vegans, may make good the deficiency with linseed oil, which is very important in that role. Like rapeseed oil it contains the Omega-3 acid alpha-linolenic acid, but unlike rapeseed it contains a great deal of it.

The benefits of using the linseed oil impinge most strongly upon the health and functions of the cardiovascular, nervous and immune systems. Animal work has demonstrated that the Omega-3 fatty acids are supportive of memory and learning, the difference being seen most strikingly when the acids are fed to a previously deficient animal.

Key physiological and health roles of Omega-3 fatty acids including linseed oil and of the eicosanoid hormones deriving from them are:

- Prevention and nutritional treatment of heart disease (Stone 1996, Knapp 1997)
- Reduction of high blood pressure
- Reduction of blood levels of cholesterol and triglycerides (Harris 1989, Werner et al 2004)
- Reduction of blood fibrinogen level, reducing thrombosis risk
- Reduction of angina pectoris (Saynor et al 1984)
- Increase in the action of insulin, protecting against Type II diabetes
- Increase in the action of and effectiveness of the immune system
- The balance of essential fatty acids appears to be important in avoiding or treating autoimmune diseases
- Protection against osteoporosis
- Protection against some causes of lack of growth in children (Simopoulos 1991)



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- Protection against weakness that may develop in Omega-3 deficiency
- Prevention of menorrhoea in adolescents (Harel et al 1996, Sampalis et al 2003)
- Prevention of the following neurological problems:
  - Disturbance of behaviour
  - Lack of co-ordination
  - Parathesia (abnormal sensations)
  - Learning disability
  - Visual impairment

Animals tested in maze running become much less intelligent and less efficient in solving the mazes when Omega-3 is deficient in their diets.

The eicosanoid hormones deriving from Omega-3 tend to reduce the tendency of the blood to clot and to diminish the severity of any inflammation. The problems arising from too much Omega-6 in the diet and too little Omega-3 include a tendency towards excess clotting and too much inflammatory response. Both the Omegas also affect the status and the general competence of the immune system and affect such things as resistance to infections. Therefore, in connection with these three important functions the balance between the intakes of Omega-6 and Omega-3 becomes quite crucially important for the maintenance of health.

Eskimos living in accord with their original culture and eating a diet rich in marine fats (principally Omega-3) have, if anything, too high an Omega-3 intake. They may actually suffer more than they need to from infections due to a relative dearth of Omega-6 fatty acids in their diet. However, they suffer very little from arterial and heart disease that are prevalent in the UK, Europe and N. America (Dewailly et al 2001). Due to the diet in the UK, Europe and N. America being unduly high in Omega-6 and deficient in Omega-3, Omega-3 is the type we usually most need to attend to in dealing with diets and supplements. This crucial need is often exacerbated in western lifestyle due to high intakes of alcohol and of trans-fatty acids (fatty acids damaged by food processing methods such as hydrogenation).

For full treatment of the essentiality of Alpha-Linolenic Acid, see Plaskett (2002).

7 EPA and DHA (Omega-3)

As mentioned, the only concentrated source of Omega-3 in most people's diet is fish. It contains the Omega-3 fatty acid EPA. These initials stand for eicosapentaenoic acid, an awkward name for non-chemists. It is accompanied by DHA, docosahexaenoic acid.

Since either linseed oil or marine fish oil will do the job of delivering Omega-3 in big quantities, we have to ask what decides the preference between them. Only those who are not strictly vegan will have a choice to exercise. Where the choice is available the preference should be to include at least some marine fish oil. The reason is the immediate availability of EPA in the marine oil for application to the task of synthesizing eicosanoid hormones. EPA has a chain of 20 carbon atoms in each molecule. It is the immediate substrate from which the eicosanoid hormones can be formed, since these also have 20 carbon atoms. Hence, conversion to eicosanoids can take place rather directly and with minimum chance of the EPA being hived off into energy producing oxidative pathways that would destroy it. On the other hand the alpha-linolenic acid, which is the Omega-3 acid of linseed oil, has a chain of only 18 carbon atoms in each molecule. Before eicosanoids can be formed from it, this acid must undergo a chain-lengthening process to add two extra carbons and make it into EPA. This chain-lengthening process requires metabolic energy to make it go. There is plenty of opportunity for the alpha linolenic acid to be hived off for energy production. Moreover, in people whose metabolism is compromised – very often the very people who need extra Omega-3 fatty acids – the enzymes needed to carry out chain lengthening may be inhibited by nutritional deficiency and imbalance of various other nutrients. The answer then, is that giving EPA circumvents the chain-lengthening process, which may have come to represent a particular obstacle in people who most need this kind of help. In these circumstances EPA is the most immediately available form of assistance.

Eskimos living in accord with their original culture and eating a diet rich in marine fats (principally Omega 3) have, if anything, too high an Omega-3 intake.

DHA has 22 carbons. It is more than long enough for making the eicosanoid hormones and this chain must be shortened before being used for eicosanoid production. DHA also fulfils certain functions of its own especially in the brain and in the eye, so lack of DHA can affect development of these organs. DHA is especially important to the very young and to the elderly. Both these age groups lack the ability to lengthen the chain from 20 to 22 carbons in sufficient amounts.

These factors make EPA and DHA especially valuable forms of Omega-3 and we recommend their use in preference to ALA. Krill oil is now the No. 1 choice for supplying these due, as we said above, to its non-toxic status, its environmentally friendly harvesting and the presence of additional important nutrients.

Where ALA is used instead one must use much more of it. The Vegetarian Society Information Sheet on Omega-3 fats states that:

"15 grams of flaxseed oil provides ca. 8 grams of ALA, which is converted in the body to EPA and then DHA at an efficiency of 2–15% and 2–5%, respectively."

This gives a true notion of the superiority of marine oils over flax oil for supplying a fully effective Omega-3 supplement.

Obviously these rates of conversion represent an average performance. Those people whose conversion systems are under-functioning due to other nutritional deficiencies and imbalances, or due to their age group, will secure much less conversion. This gives a true notion of the superiority of marine oils over flax oil for supplying a fully effective Omega-3 supplement.

8 The Nature of Phospholipids

Phospholipids can all be viewed as derivatives of the triglycerides that make up fats. The molecules of triglycerides comprise one unit of glycerol combined with three units of fatty acids. In the phospholipids, one of the fatty acid units is replaced by a phosphate group with a nitrogen base attached to it. The effect is to give the substance a dual character. The phosphate-nitrogen base component is readily attracted to water and is referred to as "hydrophilic" or "polar" whilst the fatty acid part tends to be repelled from a watery environment and is referred to as "hydrophobic" or "non-polar". This structure also gives the molecule a mixed acidic and basic (or alkaline) property. Molecules of this type have interesting and quite far-reaching biological functions and properties. They play a very key role throughout the body in forming and maintaining membranes both within the cell and at the cell boundary. By influencing the properties of membranes they affect many cell functions.

Phospholipids in which the Nitrogen Base is Choline are called "Phosphatidyl Choline" or "Lecithins". Their structure is illustrated and compared to that of the entirely non-polar fats (triglyceride) in Figure 1. In some phospholipids the choline is replaced with ethanolamine, serine or inositol.

9 Phospholipids Comprise a Very Key Component of Krill Oil

Phospholipids are very important metabolites and they are important too as structural components of the cell surface membranes and the membranes within the cells. Membrane integrity and quality are very closely associated with general health. Phospholipids are closely connected with liver function and nervous system function. Phosphatidyl choline, phosphatidyl inositol, phosphatidyl serine, phosphatidyl ethanolamine and the sphingomyelins are key subgroups of the phospholipids. We focus here upon phosphatidyl choline as being predominant within this important group of lipids. The Table opposite shows the various ways in which phosphatidyl choline functions to maintain liver activity and some of the consequences of its deficiency.

It has also become clear that phosphatidyl choline is needed to help avert high blood cholesterol levels. Since high blood cholesterol indicates risk of thrombosis this is a matter of particular importance (Flanagan 1996, Holub 2002).

There is a good case for including phosphatidyl choline into any regime designed to improve overall lipid status and general health. For fuller reference to the evidence for the action of phosphatidyl choline see Plaskett (1997). For a review of the different components of the phospholipids and the role of lecithin see Bland (1982).

SUBJECT	REFERENCE
The role of membrane fluidity in influencing the biological functions of liver cells.	Cooper, R.A. 1977
The role of membrane fluidity in influencing the biological functions of liver cells.	Borochov, H. et al. 1977
Failure of cellular energy supply in hepatocytes as the reason for failure of phospholipid synthesis.	Kuntz, E.Z. 1991
Cholesterol content of hepatocytes increases due to phospholipid deficiency.	Borochov, H. et al. 1977
Cholesterol content of hepatocytes increases due to phospholipid deficiency.	Molitoris, B.A. 1987
Cholesterol content of hepatocytes increases due to phospholipid deficiency.	Schacter, D. 1984
Decreased membrane fluidity opens up calcium channels, leading to cell damage.	Hirata, F. & Axelrod, J. 1980

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10 Why the Phospholipids of Krill Oil are Immediately Bioavailable

The Fish Oils do not provide a significant amount of phospholipids. Since Krill Oil does, this is an immediate benefit to the user. The person who uses fish oil as a source of Omega-3 fatty acids might well purchase lecithin or phosphatidyl choline in addition, to ensure that adequate phospholipids are taken. So this purchase is an extra cost, which could be cut out if Krill Oil was used instead. However, this is not even the most important point. The key point here is that phospholipids are not all the same. The Krill Oil phospholipids are of an immensely superior type to those that come from the soya bean, the usual source for phospholipid supplements. This difference of type must surely be a very big factor in determining the superiority of Krill Oil in terms of its biological performance and therefore its health benefits. It is necessary to explain what the difference is.

The Omega-3 fatty acids of Fish Oil are almost entirely present as triglycerides. If you take soya bean phospholipids to make up for the lack of these in the Fish Oil, you obtain phospholipids in which most of the fatty acids within them are the Omega-6 type, not Omega-3. Yet, one of the two crucial reasons why we need Omega-3 is to incorporate them into phospholipids so that these can be built into cell membranes. If you take in Omega-3 acids as Fish Oil, your body must first break down the triglycerides that contain them and then re-synthesise them into phospholipids, a process that requires both enzymes and energy. The need for these two processes makes the Fish Oil Omega-3 only difficultly available for incorporation into cell membranes. The great advantage of Krill Oil is that it contains the Omega-3 fatty acids already incorporated into phospholipids. The need for breakdown and

resynthesis is avoided. Hence Krill Oil phospholipids are ready-made for direct incorporation into cell membranes. Of course, this makes them much more bio-available. This may seem a subtle difference but it amounts to a real molecular distinction but it really counts in determining whether or not the body can efficiently use the Omega-3 that you take in. Krill Oil phospholipid has a particular molecular structure with EPA and DHA occupying the two fatty acid chains of the phospholipids.

11 The Carotenoids

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essential nutrients. There is a wide range of differing individual carotenoids in plants, including plants used for human foods. As the carotenoids are pigments, these are usually the red, orange or yellow fruits and vegetables. However, green vegetables also contain variable amounts of carotenoids whose colours are hidden by the intense green of chlorophyll. The carotenoids may be briefly put into perspective by discussing one member of the group, beta-carotene.

Beta-carotene is at the same time a vitamin precursor that the body uses to make vitamin A, and a phytonutrient. Carrots account for the major source of beta-carotene in North American diets, yellow-green vegetables in Japan, and red palm oil in West Africa. Studies have indicated that people who consume higher than average amounts of beta-carotene have fewer defects and illnesses that can be ascribed to free radical damage. It greatly enhances the immune system. It is a powerful antioxidant and free radical scavenger. Beta-carotene is the most efficient neutralizer of singlet oxygen, the high-energy, destructive molecule that is one of the most potent free radicals.

The normal range of human intake of beta-carotene is a few milligrams per day in western diets. However, large daily intakes of beta-carotene appear to be harmless and do not cause vitamin A toxicity. Beta-carotene is converted to vitamin A only as the body requires it. One or two hundred milligrams per day are regularly prescribed for the treatment of a disease called erythropoietic protoporphyria without causing vitamin A toxicity, liver problems, or any other apparent side effects. The World Health Organization Expert Committee on Food Additives estimated that an acceptable upper daily intake of beta-carotene for a 140-pound adult is about 350 milligrams per day. In several studies, supplemental beta-carotene in the amount of 30 milligrams per day has been used without harm but has caused the skin to go orange in a select few persons.

Several leading government agencies have recommended diets high in beta-carotene ever since the association was made between these and low rates of chronicity. Some very good diets may contain about 15-20 milligrams of carotene, while the diets recommended by the agencies suggest that a person obtain 5 milligrams per day. However, studies done by the U.S. Department of Agriculture Food Intake Survey show that the average American diet provides only 1.5 milligrams of beta-carotene a day, an insufficient amount to provide strong antioxidant protection. Adults should take 10-30mg per day according to The Alliance for Ageing Research, a Washington-based non-profit organization on ageing research.

Other important carotenoids in food include Alpha-Carotene, Beta-Cryptoxanthin, Lycopene, Lutein, Zeaxanthin, Violaxanthin, Neoxanthin. Their properties and potencies differ among the group. Several also produce extra benefits not necessarily related to free radicals, such as slowing the rate of tumour growth.

12 The Very Special Actions of Astaxanthin

Astaxanthin, which was listed in the components of Krill Oil, is another carotenoid, so it is a member of an important group of protective nutrients. However, we do not normally get the benefits of Astaxanthin from common foods. It is a specifically marine type of carotenoid. Fish do not contain much of it due to their much higher position in the food chain than the krill. The actual manufacturers of it are the tiny micro-algae that the krill eat. It is also the micro-algae that manufacture the marine Omega-3 oils. It is just that these get passed well up the food chain so that they become stored in large amounts in the body fat of fish, while the Astaxanthin does not. The special value of the Astaxanthin of krill oil comes from its especially powerful antioxidant action.

There is a test of the relative power of antioxidants called the ORAC value. This stands for "oxygen radical absorbance capacity". It measures the capacity to block the peroxy radical, one of the more common oxygen-derived radicals in vivo. Dr. Paris Kidd, well-known advisor and writer on nutritional supplements, has written that in direct ORAC comparisons milligram for milligram, the value of krill oil was found to be some 48 times that of fish oil and 34 times that of coenzyme Q10. This helps explain its exceptional stability of this oil against oxygen, heat and light. But this powerful effect is bound to continue within the cell membranes of the body. It is specifically a cell-membrane antioxidant since, being a lipid, it dissolves in the lipid of the membrane. It is particularly effective at quenching singlet oxygen and hydroxyl radicals, two highly reactive oxygen derivatives that are by-products of cell energy production. Paris Kidd goes on to say that Astaxanthin protects against: "Smoking, chemical pollutants, excessive ultraviolet exposure, antioxidant deficiency or infections can elevate these reactive free radicals to damage our cells' DNA and membrane systems. Astaxanthin is very good at protecting the cell membrane phospholipids against free radical damage (peroxidation)."

He says that this helps to explain why krill oil protects against UV-induced skin damage, inflammation (see Deutsch 2007) and neoplastic transformation (i.e. cancer) in mice. Astaxanthin also has anti-inflammatory activity in animals. A study with human subjects found that astaxanthin protected LDL cholesterol (low density lipoprotein cholesterol) against premature oxidative breakdown."

Clinical research with krill oil indicates it is far more biologically active than fish oils. It seems that the especially potent properties of astaxanthin contribute significantly to this situation. It is exciting to find that there is this entirely natural source of this very highly valued carotenoid.

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13 Direct Studies of Krill Oil Benefits

The idea of using Krill Oil rather than Fish Oil if fairly new and for this reason there are only a few recorded clinical trials of Krill Oil itself, while the very wide ranging benefits of Omega-3, phospholipids and carotenoids have been established over and over again. In one sense we hardly need the clinical trials of Krill Oil since the benefits of its components are so well established. However, the direct trials that have been recorded cover the ground of premenstrual syndrome, experienced by a high percentage of women of reproductive age (Horrobin 1983, Deutsch 1995, Sampalis et al 2003), hyperlipaemia, which is related to heart disease risk (Bunea 2004) and hyperglycaemia. Hyperglycaemia affects energy and mood swings (Young & Martin 2003).

The University of Montreal, McGill University and other medical centres in Quebec conducted a double blind, randomized and controlled clinical trial on PMS with Krill Oil. 70 women volunteers with PMS were selected, who were otherwise healthy. 36 of them were placed on Krill Oil at an intake of 2 g/day. They took this every day for the first month. Then, for a further two months, they took it for just for 10 of the days in the month. These 10 days were eight days prior to and two days during menstruation. The remaining group of 34 women were given a commercial "18:12" fish oil (18 percent EPA, 12 percent DHA) instead of Krill Oil, at equivalent intake, as a control.

Ten parameters that officially define PMS, were measured at the start, after 45 days and after 90 days.

The report is quoted below, giving the main finding of the trial:
Krill Oil was effective for all the menstrual difficulties, whether physical or emotional. It had a 100 percent range of benefit (all 10 of the 10 measures improved), while the Fish Oil was only 30 percent effective (3 of the 10 measures). Krill oil worked faster, being fully effective by the second menstrual cycle while the Fish Oil took 3 cycles to reach its maximum 30 percent benefit. Unlike the Krill group, 64 percent of the women taking the Fish Oil complained of unpleasant reflux effects. Krill oil preferentially benefited breast tenderness, feeling of inadequacy, stress, irritability, depression, joint discomfort and bloating. Both groups improved on weight gain, abdominal discomfort and swelling.

Both my physical and emotional symptoms have improved by nearly 100 percent… With a vivid interest, I recommend Krill Oil to all women suffering from these ailments."

Subjects taking Krill Oil reported improved alertness, energy, and well-being. Their need for analgesic drugs declined. One woman said, "Both my physical and emotional symptoms have improved by nearly 100 percent . . .With a vivid interest, I recommend Krill Oil to all women suffering from these ailments." Relief of painful menstruation was also reported from Denmark (Deutsch 1996).

Blood lipid abnormalities that are endemic in Western societies and contribute to heart disease are raised LDL cholesterol (low density lipoprotein cholesterol) and total cholesterol, reduced HDL (high density cholesterol) and high triglycerides."

So another trial was conducted, also in Canada (Bunea et al 2004), to see how Krill Oil would affect these parameters. This involved 120 men and women with mild to severe hyperlipaemia, over three months. There were 4 groups of 30. One group had Krill Oil 1.5g/day, a second had Krill Oil 3g/day, a third Fish Oil 3g/day and the fourth group received only a placebo.

The results showed that Krill Oil, 1.5g/day, reduced the levels in the blood of total cholesterol, LDL cholesterol and sugar, while raising the level of HDL, thus reversing the trend towards a blood lipids and sugar pattern that increases the risk of heart disease. At this level of intake it was found to be superior to Fish Oil (at 3g/day) for lowering of LDL cholesterol and blood sugar. When the Krill Oil intake was increased to 3g/day it had the extra effect of lowering the blood triglycerides, which Fish Oil did not do.

There was also an absence of Fish Oil's less pleasant after effects, that affect some people, of regurgitation and fishy after taste.
The workers doing the trial stated that the Krill Oil "outperformed Fish Oil in benefits, potency and tolerability". They considered that "Krill Oil is at least twice as effective as Fish Oil milligram for milligram and works faster"

14 Omega-3 Phospholipids are Safe and Well Tolerated

Tests have shown Krill Oil to be safe and well-tolerated when used for either humans or animals. It is clear that even normal healthy subjects benefited from its use, reporting better skin and hair quality, less joint discomfort and less in the way of seasonal allergy symptoms.

Omega-3 acids reduce blood viscosity and so should not be used at the same time as anti-clotting drugs, as the two could synergise and produce too much effect. Also, those with known allergy to other seafoods would be best not to risk its use.

The recommended daily intakes are, for menstrual cycle benefits, 1000mg – 500mg and for cardiovascular benefits 1500mg – 3000mg. It is reported as better to start with the higher intake and reduce this after about 2 months so long as the benefits can be maintained at that lower level.

It is emphasised that Antarctic Krill Oil is stated to be almost free from heavy metal contamination and that it is a renewable, abundant and sustainable source of splendid nutrients.

15 Likely Further Uses

Clinical reports are also showing potential for Krill Oil in relief of knee, shoulder, finger and other arthritic pains and for improving joint flexibility. Some users of Krill Oil report improved calmness and tolerance for stress, along with higher energy and general well-being. In view of Krill Oil's key constituents, we would also expect the Oil to relieve or improve some problems of slow mental development, such a delayed use of language in children. Research is continuing along these lines and a further, larger study of the cardiovascular benefits is also under way. The whole Oil is a powerful anti-inflammatory complex and as such, one would expect its eventual range of application to be very wide.

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Dr. Lawrence G. Plaskett

Lawrence graduated from Cambridge in Natural Sciences in 1956, specialising in biochemistry. He did research with the Medical Research Council at UCH Medical School. He became a Lecturer in Biochemistry at Edinburgh University Medical School (1960-65), where he taught students and researched the thyroid gland and autoimmune diseases.

He was Research Director of the Brooke Bond Liebig Group, 1964-74. He set up anew the Group's R & D Department as a multi-disciplinary resource of 150 staff, carrying biotechnology projects to factory scale. He managed a joint research programme with the Coca Cola Company, on instant beverages. He developed food products and food ingredients for the Group worldwide, researching novel protein foods from fungi and spun vegetable protein.

He initiated the Group's crop diversification programme for their plantations overseas, working on quinine from Cinchona, gallic acid from Tara, diosgenin from Fenugreek and Dioscorea and flavourings from Cinnamonum spp. This led to a lifelong interest in special biomedical substances from plants, (pharmacognosy). He joined the Board of the National College of Food Technology and became a Chartered Chemist and a Fellow of the Royal Society of Chemistry (C.Chem., FRSC) and a Fellow of the Institute of Food Science and Technology (FIFST). He has some 36 publications in the scientific literature and is author or co-author of 12 UK or US patent applications relating to food products and process development.

In 1974-5 he established his own Biotechnology and Process Development Company serving the Food and Energy Industries. He acted as a Consultant on renewable biofuel projects for the UK Department of Energy, for the Commission of the European Communities, for the Scottish Development Agency, and for the Government of Brazil's Minister of Technology in connection with their national programme to replace petrol as automotive fuel with alcohol. He wrote some thirty scientific reports on this work, and co-authored a book on Renewable Energy Resources (Biomass as Fuel, L.P. White & L.G. Plaskett, 1981, Academic Press).

Within the Food Industry he consulted for Cadbury Typhoo, the Albright & Wilson Group, Johnson & Johnson, Associated Biscuits, General Foods, Viscose Closures, International Protein Research, F.G. Angel & Co., Royal Scholten Honig and Wassenen Nederland, among many other food companies, and also The Food and Agriculture Organisation of the United Nations (F.A.O.), in Rome, South India and in South Korea.

He became convinced about the validity of many Alternative Medicine Disciplines, including Naturopathy, Nutritional Medicine and the various energy therapies. In 1982 he became a qualified practitioner of Traditional Chinese Acupuncture, operating his own full time clinic in Devon from 1982 -1989 inclusive, also working later in London's Upper Harley Street and in Manchester.

From 1985 onwards he established a company for the sale of vitamin and mineral products of his own concept and design. This, in conjunction with his earlier experience in larger scale industry, gave him good exposure to both production and marketing. After selling that Company, he has concentrated upon teaching, writing and research in Nutritional Medicine.

Lawrence Plaskett is the Founder and Principal of a College of Nutrition and Nutritional Medicine and has trained some 4,000 students in the last 30 years. Some of his training Courses are available at the Plaskett International College, see: www.plaskett-international.co.uk/. He is a respected, and recognised innovator in the field of mineral nutrition. He is the author of many articles on Nutritional Medicine dealing with individual nutrients and their relationship to certain named clinical conditions.

He published a monograph on the Health and Medical Use of Aloe vera, plus a series 15 of biomedical newsletters on Aloe vera, further Newsletters on Phospholipids, Vitamin E, Vitamin C and the Proanthocyanidins, among others. He consulted with US, UK and European companies on Aloe vera and had a long working connection with the International Aloe Science Council of Dallas, Texas. He also consulted for companies in the slimming product business, companies selling enzymes, general nutritional products and for a Research Trust in a nutritional cancer research programme.

He has authored a book on the role of Nutritional Medicine in Cancer, available as an E-Book or in hard copy – see: www.plaskett-international.co.uk/.

He sees modern biochemistry as the basis of an important bridge that can be built relating the causes of medical conditions to the underlying cellular biochemistry, and hence leading towards nutritional solutions.

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