



Krill are at the heart of the ocean's food chain, with a total biomass of between 400M and 600M tonnes. Krill oil supplements are gaining in popularity but there are concerns over the impact krill fishery may have on the ocean's ecosystem. Charlotte Niemiec writes

A licence to krill

Is krill oil the new fish oil? Krill oil is growing more and more popular in the public eye and in the media, as rumours abound that it has as many – if not more – positive health benefits to the human body than fish oil.

But what are krill? And what makes krill oil different, or superior, to fish oil?

Krill are small – up to six centimetres – shrimp-like crustaceans at the base of the ocean's food chain. They are the most prolific species on the planet with a total estimated biomass of between 400M and 600M tonnes, and include 85 species. A large number of ocean creatures rely on them as a source of food, including whales, seals, penguins, albatross, and many other birds. The annual reproduction rate for krill is at least several hundred million tonnes, making it a sustainable fishing resource. Krill oil companies argue that this high rate of reproduction renews the standing stock of krill at a sufficient rate to prevent over-fishing.

Krill oil contains high amounts of eicosapentaenoic acids (EPA) and docosahexaenoic acid (DHA), which are omega-3 fatty acids also found in fish oil, and phospholipid-derived fatty acids (PLFA), mainly phosphatidylcholine, known as marine lecithin.

Although still relatively unproven, omega-3 is said to have positive effects on certain cancers, cardiovascular disease, inflammation, developmental disorders, brain and cognitive abilities, psychiatric disorders and cognitive aging (see 'Omega-3 goes global', p24).

An article in *The Globe and Mail*, published in April this year, explains that the concentration of omega-3 fatty acids is lower in krill oil than in

fish oil. However, "manufacturers say the body can absorb the omega-3 fats in krill oil more readily than those in fish oil. That's because a large portion of the DHA and EPA in krill oil is bound to phospholipids. The physical properties of phospholipids allow them to dissolve in water, allowing them to be easily absorbed. The omega-3 fatty acids in fish oil, on the other hand, are attached to triglycerides, which don't readily dissolve in water. The fact that krill oil contains readily absorbed phospholipids suggests that a smaller dose of omega-3s from krill oil may be equally effective as a higher concentration found in fish oil."

There is, as yet, very limited research on whether krill oil outperforms fish oil, or on omega-3 from krill oil in general. Studies suggest krill oil can help lower blood fats and increase HDL ('good' cholesterol), due to the presence of astaxanthin, an antioxidant that comes from the algae krill feed on, which gives krill and lobster their pink colour.

Other studies suggest the oil is effective at relieving the symptoms of premenstrual syndrome and rheumatoid arthritis, according to *The Globe and Mail* article, but these studies were criticised for design flaws.

The majority of krill is harvested for aquaculture feed, but krill harvested for human consumption is one of two species: *Euphausia Superba*, or Antarctic krill; and *Euphausia Pacifica*, Pacific krill.

A growing krill oil market

A number of companies specialising in krill fishing have been established in the last few decades. Scandinavian AkerBioMarine and Canadian

► Neptune Biotech are two such companies that harvest krill and sell the oil to consumers in this fast expanding industry.

AkerBioMarine is an integrated biotech company providing bio-marine ingredients. It has received Marine Stewardship Council (MSC) marine sustainability certification for its dedication to environmentally friendly harvesting practices.

Neptune Biotech is a pioneer in the research, development and commercialisation of natural, marine-derived krill extracts. Neptune and its subsidiaries – including NeuroBioPharm and Acasti Pharma – own 85 issued patents, 17 applications and numerous trademarks in more than 30 countries.

According to Neptune Biotech, the omega-3 market will continue its growth from US\$1.8bn in 2011 to reach more than US\$3.1bn/year in sales within the next few years, driven by demands for dietary supplements, functional food and drinks, and the pharmaceutical industry. Neptune explains that omega-3 sourced from marine oils is the fastest growing sector in the polyunsaturated fatty acid (PUFA) ingredient market.

Sustainability concerns

Krill is vital to the ocean's ecosystem and, as more and more companies fish for krill, concerns are growing among scientists and environmentalists, who argue that krill numbers have depleted by up to 80% since the 1970s, with global warming considered the main suspect. This uncertainty is of great concern to NGOs, such as Greenpeace and the World Wildlife Fund (WWF), and also to scientists, who express fears that there is no sure way to estimate population numbers or to know the long-term effects harvesting krill may have.

A 2009 report, conducted on behalf of Greenpeace, by Paul Johnston, David Santillo, Richard Page and Cat Dorey of the School of Biological Sciences at the University of Exeter, UK, examined the impact of krill harvesting alongside reputed depleting numbers of krill. It gives the following background on volumes harvested:

"The krill fishery began in the 1970s and reached a peak in the early 1980s, when around 500,000 tonnes were taken. It stabilised at around 400,000 tonnes from 1986-1987 through to 1990-1991 and then declined further to 87,000 tonnes in the 1992-1993 season, rising again to around 100,000 tonnes in 1999. Catches reached around 126,000 tonnes in 2001-2002, falling slightly to 104,000 tonnes in the 2006-2007 season."

The WWF adds: "Following a decrease from 1992-2009, catch levels were around 210,000 tonnes by 2009-2012 and there was concern that krill fishing was on the increase again, but catches dropped again to just under 181,000 tonnes in 2010-2011."

To combat the problem and prevent over-fishing the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established by international convention in 1982. Its objective was to conserve Antarctic marine life in response to increasing commercial interest in Antarctic krill resources. It practises an ecosystem-based management approach, which does not *exclude* harvesting but which ensures it is carried out in a sustainable manner, and takes account of the effects of fishing on other compo-

nents of the ecosystem. Twenty-five countries have now joined the organisation.

As of January this year, the CCAMLR has set a total catch limit for Antarctic krill in Area 48 of the Southern Ocean – where most of the fishery is focused – of 5.61M tonnes, but in practice a more precautionary catch limit is set at 620,000 tonnes. Scientists say they are monitoring the fishing but so far, total catch levels are a small proportion of the population.

Finding a friendly fishing method

A further ecological impact of krill fishing is the danger of bycatch – capturing other marine animals, such as seabirds and non-commercial fish species – states the WWF.

Krill are fished using fine nets, which pose a problem in that they tend to clog quickly and have a high drag that produces a bow wave, which pushes krill to the sides. Furthermore, the act of bringing krill on board squeezes the krill together and liquid (oil) is lost as a result.

New methods needed to be found that reduced bycatch and ensured a maximum krill catch, with a minimum liquid loss. One new method of fishing is using suction tubes to pump krill on board, a method that has had some success; it increases the capture capacity and the processing rate of krill. According to the University of Exeter report, some of these ships have facilities on board to manufacture biodiesel from krill.

AkerBioMarine's krill trawler – the FV Atlantic Navigator – used the suction technique in the 2003-2004 and 2004-2005 fishing seasons. This ship alone caught 25% and 38% of the whole krill catch in CCAMLR regions. Its successor ship, the FV Saga Sea, can capture up to 120,000 tonnes/year of krill.

The efficiency of these ships ties into overfishing concerns, especially as more and more ships are being built.

Certification, standards and patents

The Marine Stewardship Council (MSC) offers certification to the krill fishery market. So far, just one vessel – operated by AkerBioMarine in Area 48 – has received MSC certification. In order to be

eligible, a company must prove that: it is fishing sustainably and not exploiting resources; it is minimising environmental impact; and that the fishery meets all local, national and international laws and has a management system in place to respond to changing circumstances and maintain sustainability.

The Exeter report argues that the MSC should not certify krill fishery while there is uncertainty regarding population numbers and the impact of climate change on the species.

Patents have been issued for krill oil supplements. In April, *Lipid Technology* reported that Neptune Biotech had been granted a new continuation patent by the US Patent and Trademark Office (USPTO). Patent 8,383,675 contains a single claim regarding 'a capsule comprising an Antarctic krill oil extract comprising a phospholipid suitable for human consumption.' It is related to prior patents 8,030,348 and 8,278,351, which are currently under re-examination by the USPTO, at the request of AkerBioMarine. The new patent will, in effect, cover almost all krill oil supplements and pharmaceutical products currently on sale in the USA.

According to the report, this is just the latest stage in an ongoing dispute over intellectual property rights in the krill sector. As third parties are now allowed to comment on a patent application while it is being considered, a number of patents have been granted to either Neptune or its competitors in the last couple of years, only for other interested parties to file for re-examination.

In other news, the Food Chemicals Codex has completed its new monograph for krill oil. Under construction since 2009, it has received considerable input from the leading players in the krill industry, as well as using information supplied to regulators.

A significant concern with identifying krill oil has been to distinguish it from products sold under the name, but containing phospholipids from other sources. The new monograph contains an NMR method to test the total phospholipid content in krill oil.

If the NMR tests yield positive results, it looks likely that the krill market will see significant growth over the next few years. ●

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THE OCEAN'S LARGEST CREATURES RELY ON KRILL AS A FOOD SOURCE

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