

GM omega-3 source developed

20/09/2004 - Scientists have succeeded for the first time in genetically modifying an oilseed crop - linseed - to boost its levels of very long chain poly-unsaturated fatty acids (PUFA), associated with a raft of health-promoting properties, writes Lindsey Partos.

A raft of well-documented research over the past few years has pointed to the health benefits – from anti-cancer and arthritis protection to heart health and brain development – of omega-3 PUFAs, most commonly sourced from fish oils.

But scientists at the University of Hamburg in Germany report this month in *The Plant Cell* that they have managed to design linseed plants that accumulate significant levels of PUFA in the oilseed crop linseed.

They claim that their findings could help to relieve pressure on diminishing fish stocks – and ultimately problems of sourcing - as demand rises for edible oils that are low in saturated fats and high in poly-unsaturated fats. In addition, certain fish stocks have been associated with contamination of pollutants, such as heavy metals and dioxins.

"The production of these oils in plants may reduce environmentally and economically unsustainable pressures on both wild and farmed fisheries," say the scientists led by Ernst Heinz.

But a clear resistance to market growth for the GM linseed will be the consumer's current suspicion of genetically modified foods.

Fatty acids, long straight chains of carbon atoms, are essential components of the membranes of all living organisms and PUFA are increasingly recognised as important components of a healthy human diet.

Parallel to the consumer's growing awareness of the PUFA benefits, the food industry is increasingly turning to such ingredients to provide health value to their end food products.

A recent report from market analysts Frost & Sullivan stated that of all the functional food ingredients currently available, the future for omega-3 polyunsaturated fatty acids looks the most promising.

Growing consumer demand for fortified foods has helped foster a European market worth \$195 million (€161m) for omega-3 PUFAs, accounting for 28 per cent of the global market volume.

While the annual growth rate for the total European omega-3 PUFA market in 2003 was 11 per cent, it is likely to stabilise at a lower rate of 8 per cent in the coming years. Europe is a more mature market compared to the US where some market participants are experiencing growth rates of over 20 per cent.

Oilseed crops, such as canola, safflower, and linseed, typically accumulate a high proportion of C18 PUFA such as linoleic acid and alpha-linoleic acid in their seed. These are called "essential" fatty acids for humans, because they are not synthesised in the human body and must be obtained from dietary sources.

Once consumed, they may be metabolised into very long chain (C20 and C22) PUFA in the human body. This process is slow and inefficient compared to the direct consumption of C20 and C22 PUFA that may be obtained from fish oils.

"Oilseed crop species contain all of the proteins and enzymes necessary for the biosynthesis of the range of fatty acids present in seed oil, but they lack the few additional enzymes (certain fatty acyl desaturases and elongases) necessary for the biosynthesis of very long chain PUFA," say the researchers.

The combined research programme between BASF Plant Science in Germany, Rothamsted Research Station in the UK, and Kansas State University in the US, produced linseed *Linum usitatissimum* and tobacco (*Nicotiana tabacum*) plants that synthesise very long chain PUFA in their seed by introducing genes for fatty acyl desaturases and elongases in genetic transformation experiments.

First, protein sequences for fatty acyl desaturases and elongases were analysed from a variety of organisms that produce very long-chain PUFA, including a fungus (*Mortierella alpina*), alga (*Phaeodactylum tricornutum*), moss (*Physcomitrella patens*), nematode (*Caenorhabditis elegans*), and another plant (*Borago officinalis*).

DNA coding sequences for these genes were then introduced into linseed and tobacco plants, and expression of the proteins directed into the seed with the use of seed-specific gene promoter sequences.

"The best results were obtained with the use of the plant and algal gene sequences. These transgenic plants accumulated significant levels of very long chain PUFA in their seed," report the scientists.

Not only targeted at human consumption, the researchers claim that their work could lead to the production of high quality animal feed that could improve the PUFA content of animal products such as meat, eggs, and dairy foods.

This latest research could also breath new life into Europe's flagging linseed industry that has been knocked in recent years by increasing production of rape seed – easier to grow and currently achieving higher market prices.

Used primarily for industrial purposes, the biggest global supplier of linseed is Canada, also known as flaxseed, which produced nearly 1 million tons last year. Global production is around the two million ton mark.

Full findings of the GM linseed study are published this month in [*The Plant Cell*](#).