More plastic from plants

Plant oils might replace petrochemicals as the basis of plastics if an Australian-Swedish team succeeds.

Most people associate vegetable oils with salad dressings and pasta dishes. But they are also important in the production of resins, plasticisers, glues, surface coatings and lubricants. Of the two million tons of plasticisers produced globally, for example, 75% are synthesised from petrochemicals, while 25% originate from ‘chemically epoxidised’ soybean, linseed and tung oils.

Unfortunately, the need to epoxidise commercial vegetable oils – a process that alters the structure of the fatty acids in oils to produce ‘epoxy fatty acids’ – makes them more expensive and inefficient to use. What industry needs are oils that already contain industrially useful fatty acids. A source of such oil would also provide a renewable and biodegradeable alternative to our dwindling petrochemical reserves.

CSIRO scientists in Canberra could soon supply this demand, thanks to research that aims to harness the ability of some plants to produce epoxy fatty acids. In collaboration with scientists from Sweden, Dr Allan Green, Dr Surinder Singh and Dr Xue-Rong Zhou have isolated and cloned a gene (*Cpal2*) which directs the synthesis of epoxy fatty acids in *Crepis palaestina* – a relative of the dandelion. The team aims to insert this gene into a commercial oilseed crop, such as linseed, to produce commercial quantities of epoxy fatty acid. But there are a few challenges to overcome first.

‘*Crepis palaestina* seeds contain about 70% epoxy fatty acid, but when we transfer the *Cpal2* gene to linseed, we get only 2% epoxy fatty acid produced,’ Singh says.

‘We need at least 50% epoxy fatty acid production for commercial purposes. So we’ve been trying to understand the function and expression of the gene to determine why it isn’t operating to its full potential in linseed.’

Part of the answer may lie in the need for other genes involved in the biochemical pathway that leads to epoxy fatty acid production in *C. palaestina*. The team will now insert these genes, along with the *Cpal2* gene, into *Arabidopsis* (the ‘lab-rat’ of the plant world), to see what happens.

‘We want to get the *Cpal2* gene to function to its full potential in *Arabidopsis*, and then transfer that capability to linseed,’ Singh says.

If the team succeeds, their findings will likely be applicable to a family of genes that direct the synthesis of other industrially useful fatty acids. These include genes for the production of hydroxy fatty acids, found in castor oil and used in lubricants and inks; conjugated fatty acids from tung seeds; and acetylenic fatty acids found in another dandelion relative, *Crepis alpina*.

‘Other leading international research groups are helping to develop these fatty acids’, Singh says.

‘Swedish colleagues are working on producing acetylenic fatty acids, which could be used in the production of nylon, specialty chemicals and lubricants.’

Singh says farmers, industry and society will benefit from the technology.

‘Farmers will have expanded market opportunities for their crops and will generate higher returns. The new crops will increase the genetic and biological diversity in agricultural production systems. Industry will be able to avoid costly chemical processing steps and minimise environmental impact. And society will benefit from the reduced depletion of non-renewable resources,’ he says.

Companies switching to a plant-based epoxy product will have a marketing advantage associated with using a ‘green raw material’. **Wendy Pyper**


CSIRO Plant Industry

Linseed is under trial as a plastic plant.

This work is funded in part by BASF Plant Science GmbH .

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MORE READING:

Singh, S. *et al* 2001. Transgenic expression of a Δ12-epoxygenase gene in *Arabidopsis* seeds inhibits accumulation of linoleic acid. *Planta,* 212: 872–879.

Lee, M. *et al* 1998. Identification of non-heme diiron proteins that catalyze triple bond and epoxy group formation. *Science,* 280: 915–918.

‘These values clearly indicate that the Intergovernmental Panel on Climate Change (IPCC) default value of 10 years, for the calculation of the complete mass loss of above ground biomass following land-use change and forest harvesting, is unrealistic,’ Bauhus says.

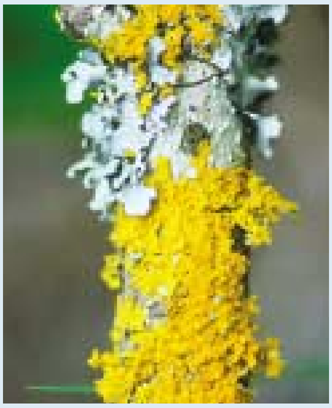
For native Australian species, lifetimes derived from wood durability studies ranged from seven years for *Eucalyptus regnans*, to 375 years for *E. camaldulensis*. However, as the experimental conditions under which these studies were conducted were substantially different from wood decay conditions in the field, Bauhus says that the majority of these estimates must be regarded as minimum lifetimes for most species. Better information could be obtained through long-term decomposition studies of wood debris in different environments.

‘Our review indicates that further investigation of the determinants of wood decomposition is needed, to permit a modelling approach to an estimation of CWD turnover and the release of CO_2 from decaying wood,’ Bauhus says.

Wendy Pyper

MORE READING:

J Mackensen, J Bauhus and E Webber (2003). Decomposition rates of coarse woody debris – A review with particular emphasis on Australian tree species. *Australian Journal of Botany*, **51:** 27–37.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Lichens accelerate wood decay.