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Algae - the slimy scum that could end the fuel crisis

Oil produced from algae could soon start fuelling our cars, and even be baked into our birthday cakes.

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Could this green stuff be the future of fuel? Photo: NATIONAL TRUST

It's green, slimy and one of the simplest organisms on the planet, but it could hold the key to the impending global fuel crisis. Algae, the scum that coats ponds, puddles and pavements, has the potential to be turned into oil capable of powering planes, trains and cars.

Estimates of when our oil reserves will run out vary widely, but we are already looking for alternatives. One of the most popular has been biofuel: oil derived from corn, rape and soya. Until recently, an EU target stated that by 2020, 10 per cent of the fuel we use to power our vehicles should come from crops. The wording has now been modified to include other forms of renewable power, such as electricity, but even so many scientists suspect that the target is unlikely to be met. In 2007, EU countries produced 5.7 million tons of biofuel, just two per cent of the amount that would be required.

And that is not the only problem, as Dr Richard Pike, the chief executive of the Royal Society of Chemistry, explains. "Typically, the figure for the gross amount of biodiesel produced per hectare excludes the cost of fertiliser, harvesting, transportation," he says. "You actually end up with as little as one or two tons."

Such fuel crops also require land that could be used to grow food: "In the long term, biodiesel is unsustainable, because for every one per cent of diesel fuel you want to replace in the UK, you need to use one per cent of our land area."

According to its proponents, producing biofuel from algae would get around this problem, because the organism neither competes for arable land nor requires nutrients. Instead, algae use sunlight and carbon dioxide to produce minute amounts of nutrients – lipids (fatty oils) – which can, after processing, be used as biodiesel. Algae grow at a phenomenally fast rate and have a very high yield: 10,000 gallons of biodiesel per acre compared to 48 gallons from soya and 120 gallons from rape.

There are two main ways that algae can be grown: by "fishing" or "farming". "Fishing" is a low-tech, low-cost technique whereby wild strains of algae are cultivated in open ponds. "Farming" is more sophisticated, with the algae grown in photo-bioreactors – translucent plastic or glass tanks. Arguments over the best technique continue: the farmers say that the fishers' process is flawed because the variables – temperature, light, water evaporation and contamination – cannot be controlled, while the fishers claim that the farmers' bioreactors require an energy supply and are expensive to maintain. Will Thurmond, chairman of research and development at the National Algae Association in America

(where all but one of the major algae biodiesel firms are based), believes that pure economics will eventually choose between them: "For research purposes, growing algae in photo-bioreactors is better, because you can control all the variables. But once the research has been completed by all the companies involved and moves into large-scale production, the debate will be resolved."

But once you've got the vast amounts of green sludge, how do you go about extracting oil from pond scum? "The old method is to take algae out of a pond with a fishing net, dry it out and literally squeeze the oil out," says Thurmond. "More modern methods have required chemical solvents, but recently the University of Texas has developed a way of using ultrasonic waves to rupture the cell walls: the oil rises to the top of the container and you can skim it off the top of the cells. This is the preferred method, as it's non-polluting, but it's not yet advanced enough to be commercially viable."

Whatever the method employed, the extraction procedure can be costly and complicated, and further processing is still required before the algae can be turned into vehicle fuel. The cost of this has dropped dramatically: to make algae biodiesel in the lab 25 years ago cost $3,000 per gallon; today it is less than $20. However, in the US, petrol costs $2 per gallon and diesel $2.70 – to be competitive, algae biodiesel would need to be around the $2 mark, too. As Thurmond admits, "It's the last yard that's hard."

Yet a solution to that cost problem could be available from a familiar figure in the world of genetic engineering. The renowned American scientist Craig Venter has – with his team at Synthetic Genomics in California – developed bacteria that require only sunlight and water to grow, and secrete the required oil as a by-product of the metabolic process. Professor Venter, who was the first person to have his entire genome sequenced and hopes to become the first to create an entirely synthetic life form, says that if he can raise the funding to build a pilot plant, his bacterial oil could be pumped straight into an existing refinery.

Whichever modified micro-organism the new oil comes from, there is one significant drawback. Although they will work in cars, biofuels aren't up to the demands of the aviation industry, as they freeze too easily in the sub-zero temperatures at high altitude. Yet finding a replacement for jet fuel is vital: the aviation industry uses 1.6 billion gallons of fuel a month in the US alone, so an alternative source would significantly reduce its carbon footprint.

But here again algae could succeed where crops can't. Solazyme, a "synthetic biology" firm in San Francisco, has produced an algae-based kerosene suitable for commercial and military jet engines, by using a strain of algae that produces an oil naturally analogous to aviation oil.

Solazyme has also dispensed with what scientists had thought was the key ingredient in growing algae: sunlight. Dr Harrison Dillon, the president and chief technology officer, says that they grow their sludge in the dark, "feeding" it with sawdust, or the waste left over from sugarcane farming. "It's a thousand times cheaper to produce oil this way than having algae sitting in the sun," he says. "Our algae cells are so fat they're literally bursting with oil, which makes it easy to extract.

"Essentially, we're making [a form of] crude oil, and we can turn it into any product that's made from crude oil – which potentially includes many of the things in the home, from cosmetics, to cleaning supplies to plastics and clothes."

The company also produces an edible oil, which has a nutty flavour and is more nutritious than olive oil. "The price of plant oils has been skyrocketing in recent years. We can take non-edible material like sawdust and use algae to produce this nutritious cooking oil. It even tastes pretty good. This year my birthday cake was made out of it."

So how long will it be before oil from algae is a commercial reality, whether in our kitchens or in our cars? "The optimists say it'll be as soon as 2010," says Thurmond, "but I'm more pessimistic. It remains to be seen whether companies can attract the capital required or their process stands up scientifically. I think it'll be three or four years from now."

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