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Myco-diesel – The discovery of another alternative source of biofuel

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Access to cheap energy is a linchpin of modern industry and civilization. Energy, mostly from fossil fuels, allows us to power factories and transportation systems. Worldwide every day, we devour the energy equivalent of about 200 million barrels of oil, but much of this energy comes from coal, gas and nuclear fuel. Although solar powered devices and solar cells emerge like mushrooms, we still need an immediate solution to power our automobiles, until old fuels are completely replaced. Hydrogen fuel cells have enormous potential if technical problems can be solved. Essentially a kind of battery that can be continuously refilled, fuel cells chemically react hydrogen with oxygen-producing just electricity and water.

Biofuels have been promoted as good alternatives to fossil oil, which is sourced from politically volatile regions of the world and is a major contributor to the greenhouse effect. One of the downsides of biofuels has been their impact on the world food market, because the present generation of fuels is derived from food crops that are grown on agriculture land.

Biofuels have been around since the internal combustion engine. Ethanol is added to petrol in the US, and millions of cars in Brazil are run on it. Vegetable oils are already used in Europe to produce biodiesel. Soya oil could be used for aviation sector too. Biofuels such as fast-growing elephant grass or saplings could be used to provide heat and electricity. Next-gen biofuels have struggled in part because the process of breaking down plant biomass and converting it into fermentable sugars so it can be refined into fuel is too expensive to be commercially viable. In other words, it cannot compete against corn-based ethanol prices or gasoline, for that matter.

Finding newer methods for reaching to biodiesel must not interfere with people's way of living, and it must in any circumstance not make food more expensive. Additionally, it must not be an excuse for stopping or slowing the true clean and alternative energy research.

Myco-power: Heat tolerance is the critical cost-reduction piece of the puzzle. Many cellulases used in biofuel production thrive at temperatures of 20°C to 35°C. The conversion process at these temperatures takes time, during which contaminants can reduce the final yield, and that means higher costs.

Researchers concluded that the refining process could be speed up by raising the temperature of the reaction. That means finding enzymes that can survive the heat. The use of heat-loving fungi can be considered much important to find heat tolerant enzymes from fungi and microbes such as cellulases that break down plant cell walls and convert biomass into fermentable sugars. Now scientists have identified two heat-loving fungi (*Thielavia terrestris* and *Myceliophthora thermophila*), the information can be used to improve strains as well as simplify the identification of other beneficial and harmful mutations.

Another discovery in the field of biofuel came by mistake only. Its potential is so startling that the discoverers have coined the term "myco-diesel" - a derivation of the word for fungus - to describe the various hydrocarbons that it produces as a gas. A reddish microbe discovered at a secret location in the rainforests of northern Patagonia (Argentina) and (Chile) has been found to expel hydrocarbon gas, with promise as a new source of biofuel. A microbe that thrives inside the trunk of a tree could prove to be the future source of biofuels. Oddly enough, this remarkable discovery was the result of serendipity. The fungus can even make these diesel compounds from cellulose, which would make it a better source of biofuel that anything we use at the moment.

Gliocladium roseum is a fungus from the Patagonian rainforest, which also grows on wine grapes. It cannot be burned directly, but it seems to produce diesel fuel (or at least molecules found in diesel), out of cellulose. This is the only organism that has ever been shown to produce such an important combination of fuel substances. Montana State University made an experiment that concluded that these species of fungi can grow on cellulose and produce hydrocarbon and derivatives that look much like diesel. This fungus is like a diesel converting plant, that's why the fuel it produces has been named "myco-diesel".

The first lucky break happened in the late 1990s, when Strobel's team (Dr. Gary Strobel, a professor of biology from Montana State University), working in Honduras, came across a previously unidentified fungus called *Muscodor albus*. By sheer accident, they found that *M. albus* releases a powerful, volatile antibiotic which kills other fungi. Intrigued by this, the team tested *M. albus* on the ulmo tree, whose fibres are a known habitat for fungi, in the hope that this might reveal similar types of fungus.

But *G. roseum* grew in the presence of these gases when almost all other fungi were killed. It was also making volatile antibiotics. Strobel's team grew the *G. roseum* in the lab, on an oat-meal-based jelly and on cellulose. Extractor fans drew off the gases exuded by the fungus, and analysis showed that many of them were hydrocarbons, including at least eight compounds that are the most abundant ingredients in diesel.

G. roseum also known as *Clonostachys rosea f. rosea*, is a species of fungus in the family Bionectriaceae. It colonizes living plants as an endophyte, digests material in soil as a saprophyte and is also known as a parasite of other fungi and of nematodes. It produces a wide range of volatile organic compounds which are toxic to organisms including other fungi, bacteria, and insects, and is of interest as a biological pest control agent.

Usually, biofuel production requires an intermediary step of providing a "food" source for the catalytic organisms (like food crops derived from the farming process). *G. roseum* can make myco-diesel directly from cellulose, the main compound found in plants and paper. This means that if the fungus was used to make fuel a step in the production process could be skipped.

In Strobel's study, volatile hydrocarbons and their derivates were produced when the genetically atypical strain was cultured on both oat-meal-based agar and on a cellulose-based medium. Compounds produced on the oat-meal-based medium included, an extensive series of the acetic acid esters of straight-chained alkanes, cyclohexane, isomers of decane and undecane, and others. Those produced on the cellulose-based medium included heptanes, octane, benzene, and some branched hydrocarbons. Fatty acids and lipids were also found in liquid cultures.

Myco-diesel advantages:

– The fungus is reported to hold several properties that far exceed current biofuel sources. Current biofuel sources have to refine before being converted into biofuel, a painstaking and not always environmentally friendly process. The fungus has a clear advantage over these biofuels because it produces "myco-diesel" directly from cellulose. The shortened production process means a reduction in costs and CO_2 released into the atmosphere.

– Biofuels, that the microbial organism provides, can be used for energy production and powering vehicles without increasing the CO_2 concentration in the atmosphere, which makes them highly superior to fossil fuels in light of the global warming issue.

– This is the only organism that has ever been shown to produce such an important combination of fuel substances.

– This fungus has ability to convert cellulose to hydrocarbons could provide environmental and socio-economic benefit because it may allow for organic waste products such as sawdust to be used in biofuel production instead of food sources such as corn.

– Another avenue of exploration is in cheap, plentiful non-food fibrous plants and cellulose materials, such as switch grass, wood chips and straw. But these novel sources, hampered by costs and technical complications, are struggling to reach commercial scale.

– Instead of using farmland to grow biofuels, *G. roseum* could be grown in factories, like baker's yeast, and its gases siphoned off to be liquefied into fuel.

– Another alternative would be to strip out the enzyme-making genes from the fungus and use this to break down the cellulose to make the biodiesel.

– Although the fungus makes less myco-diesel when it feeds on cellulose compared to sugars, new developments in fermentation technology and genetic manipulation could help improve the yield. In fact, the genes of the fungus are just as useful as the fungus itself in the development of new biofuels.

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