# MYCOLOGICAL INTERVENTION TO OVERCOME GLOBAL FOSSIL-FUEL CRISIS

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## Abstract

Excessive burning of fossil fuels is not only depleting natural resources but is resulting in a steady increase of carbon dioxide emissions, which experts believe is responsible for increasing average global temperatures. Mycolipases constitute one of the most important group of biocatalysts and eco-friendly alternatives to chemical catalysts for biodiesel production. Mycolipase based biodiesel is an environmentally cost effective, sustainable fuel carbon neutral energy source and may be further explored as a successful alternative to fossil fuels.

**Keywords:** mycolipase, global warming, bio-diesel, sustainability

Energy is everywhere all around us and the seven billion people habituating in the earth runs on it. Our modern lives depend on itfrom propelling our vehicles to lighting up our homes. This energy is provided by our global environment in the form of energy extracted from fossil fuels, natural gas, hydroelectricity, nuclear energy and renewable sources and ultimately returns to the environment in the form of water vapour, carbon dioxide, methane, nitrous oxide, halogens, aerosols and heat. 67% of global energy is provided by the fossil fuels, 22% from natural gas, 6% from hydroelectricity, 4.4% from nuclear energy and only 0.6% from renewable sources as wind, geothermal, biomass and solar energy[1]. The populationhas been expandingat the steady rate of 1% which has led to increased dependence on the fossils fuels for energy generation leading to fossil fuels nearing its exhaustion point in 53 years at current rate of consumption [2]. This escalation of energy demand has led to Global energy crisis. Excessive burning of fossil fuels is not only depleting natural resources but is resulting in a steady increase of carbon dioxide emissions, which experts believe is

responsible for increasing average global temperatures. This was demonstrated by the Intergovernmental Panel on Climate Change (IPCC) with the Hockey Stick curve which In its fourth synthesis report, 2007has told us that the "warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (fig 1).

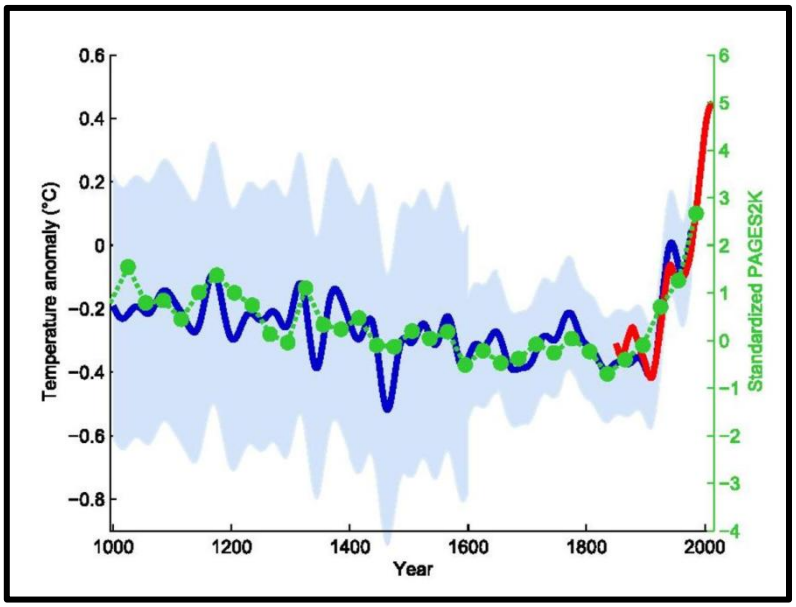


Fig 1: The original northern hemisphere hockey stick graph (Adopted from Fourth Assessment report, The Intergovernmental Panel on Climate Change, 2007)

Global energy crisis expedites the global demand for alternative, advanced renewable sustainable energy resources like biofuels which is never been needed more than it does today to reduce use of traditional fuel and greenhouse gas (GHG) emissions.Biofuels helps in reducing dependence on foreign oil and reducing supply disruptions such as those of the 1973 and 1979 oil crises, providing income and employment in rural areas, improving air quality through lower tailpipe emissions and reducing greenhouse gas (GHG) emissions because CO2 is sequestered during the production of the feedstock.Biofuels have been a part of the global energy picture since the mid-1970s. Brazil was the first major producer beginning in 1975 with the launch of its PROALCOOL program, which provided subsidies for sugarcane ethanol production[3]. This policy was mainly motivated by the 1973 oil crisis, and Brazil saw sugarcane ethanol as a means of becoming more independent from the rest of the world for liquid fuel. Production began in the United States in the early 1980s, stimulated by the National Energy Conservation Policy Act of 1978 [4].Gradually the biofuel market started expanding as EU also started investing in setting of biofuel generation industries. It is expected that global biodiesel market will be expand up to 41.4 billion liters by 2025 but it is still less when compared to fossil fuel-based industries by a big margin.So, there is a continuous need on the researches of green and ecofriendly process development for the production of biofuel to replace all non-renewable modes of energy generation.

Biodiesel is the first-generation biofuel produced from edible oil and non-edible oils through technologies like fermentation, distillation and transesterification. Biodiesel is a group of esters generally produced from triglyceride and methanol by catalyst-based transesterification reaction. The transesterification process is a reversible reaction and carried out by mixing the reactants – fatty acids and alcohol and catalyst. The catalyst can be chemical catalyst or a

biocatalyst. A strong base or a strong acid can be used as a chemical catalyst. At the industrial scale, mostly sodium or potassium methanolate is used. The end products of the transesterification process carried out by chemical catalyst are raw biodiesel, raw glycerol and chemical byproducts. Hence, biocatalysts like lipases are preferred over chemical catalysts for prevention of harmful byproducts generation.

Lipases (triacylglycerol acyl hydrolases, E.C. 3.1.1.3) are biological catalyst that catalyses the hydrolysis of long chain triglycerides into free fatty acids and glycerol. They are water soluble enzymes and under aqueous conditions, they act upon insoluble carboxyl ester bonds present in oils to generate biodiesel [5]. Many microorganisms such as bacteria, fungi and a few protozoa are known to secrete lipases for the digestion of lipid materials [6]. But fungal lipases or mycolipase have been considered as better lipase source over bacteria or other microorganisms because they offer ease of extraction for its extracellular lipase production and the enzymes can be easily recovered at a low cost [7]. They catalyse the hydrolysis of ester bonds at the interface between the insoluble substrate phase and the lipase dissolved aqueous phase [8].Moreover, they have high thermal stability as well as a high turnover number which makes mycolipase an ideal source. Soil contaminated with spillages from petrochemical and food industry harbours fungal species, which have the potential to secrete lipases with degradation capability [9]. This is because fungi are saprophytic in natureand plays a critical eco-friendly role to break down and recycle of waste oil residues with the secretions of their exoenzymes released from their extracellular wall that contains chitin [10]. They are able to survive in a wide range of environmental conditions owing to their highly efficient enzyme systems and when faced with an inhospitable condition, their psychological ability to cope with it with their enzymes serves as a high survival value. Lipases are one of the enzymes which help to flourish in their tropic niche [11].

Mycolipases constitute one of the most important group of biocatalysts and eco-friendly alternative to chemical catalysts for biodiesel production. Mycolipase-catalysed transesterification involves two steps. Firstly, it involves in hydrolysis of the ester bond and then in esterification with the second substrate [12] (fig 2).

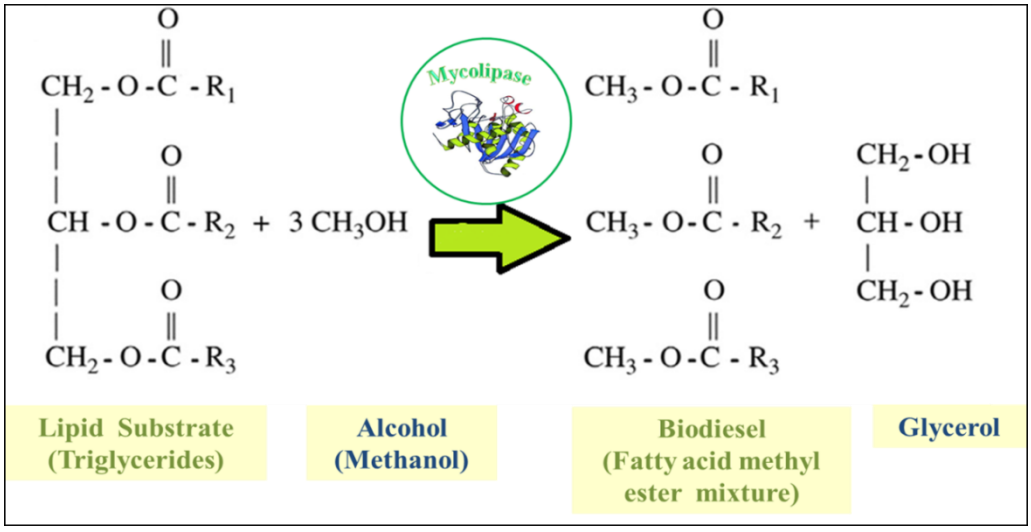


Fig 2: Mycolipase mediated transesterification process for biodiesel production; Here, $R_1$, $R_2$, $R_3$are long chain alkyl group

A majority of yeast and fungal lipases involved in biodiesel production such as *A. niger, C. antartica, C. rugosa, R. miehei, R. oryzae,* and *Thermomyces lanuginose*[13]. Production of biodiesel has been reported byHa SH *et al*. 2007 using immobilized *Candida antarctica* lipase catalysed methanolysis of soybean oil [14]. Recently, *Streptomyces sp.* was investigated as a potent lipase producing microbe for biodiesel production and found applicable in the field of biodiesel [15]. *Thermomyces lanuginosus* lipase is not only an eco-friendly tool for conventional triglyceride-based biodiesel production but also helps to utilize liquid wastes of oil industry (Palm oil mill effluent) for the same purposes to attain the challenge of sustainable and safe energy production. Biodiesel produced from waste and non-edible vegetable oil catalysed by fungal lipases have reduced the biodiesel production cost and also avoids the conflict between food and energy security and recycling waste oil[16].

Thus, mycolipase based biodiesel is an environmentally, cost effective, sustainable fuel carbon neutral energy source. Therefore, further investigation on novel fungal lipase is hypothesized to open a new arena to substitute fossil fuel usage.

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