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- S. Aanand, S. Sudarshan and S. Sundhar

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ALGAL BIOPLASTICS – GREEN PLASTICS FOR A HEALTHY ENVIRONMENT

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S. Aanand
Erode Centre for Sustainable Aquaculture, Bhavanisagar

S. Sudarshan
ICAR – Central Institute of Fisheries Education – Mumbai

S. Sundhar
Fisheries College and Research Institute, Thoothukudi

Plastics once named as the most useful product ever created, now threatens the very existence of life in the planet's oceans. Plastic is found in all forms in the oceans, primarily as microplastics, and large floating objects have been reported circulating in the Centre of the five major ocean gyres and other sub gyres. Due to their extreme durability and adverse impact on the environment, these plastics have been banned in many countries. This has led to global awareness, with China announcing a complete ban to import foreign garbage for recycling, with the EU pledging to eliminate single-use plastics by 2030. India has also shown its pledge towards greener technologies and beginning with a complete ban of single use polybags. Plastic waste has been quietly accumulating in the marine environment and shores for generations and in some of the remotest parts of the oceans forming seemingly endless and indestructible gyres of floating rubbish. Plastic bags are almost become the norm of any beaches with PCB poisoned shellfish discovered 10km below the Pacific in the Mariana Trench and even in the remote inaccessible Arctic Ocean. Plastics free life is now almost impossible these days, being found use in almost all life activities. Hence, the question arises? What is the solution to a plastic free world? The greenest answer to this has always been green or bioplastic. Several sources of bioplastics have been researched globally. However, the spotlight is now on algae, which has been identified as on dependable source of bioplastics.

HISTORY AND IMPACT OF PLASTIC ON THE MARINE ENVIRONMENT

Bakelite was the first plastic invented in New York in 1907, which was actually solid oil, with a few chemical adjustments and additives, permitting an endless range of new products to be manufactured on an unprecedented scale. However, the real plastic revolution began 50 years later in 1957 when Bisphenol A (BPA) was polymerized with Phosgene to produce Polycarbonate. Plastic appeared to be the perfect solution to the problem of food waste. It extended the shelf life and the geographical reach of existing commodities by replacing relatively more expensive glass, metal and cardboard. Generally, plastics are synthetic or semi-synthetic materials that are typically polymers of high molecular mass obtained from petroleum and natural gas. These petroleum-based products are resistant to water, chemicals, sunlight, and bacteria and their capacity to provide electrical and thermal insulation. Being relatively cheap

and the ability to be molded into various shapes and lighter weight make use of plastic grow exponentially, reaching into all aspects of modern life. Much of the present plastic pollution has been recognized as the accumulation of single use plastics and small plastic pellets, microplastics, and fibers. In recent years, the worldwide annual production of plastic estimated as more than 300 million metric tons. It's estimated that about 12 metric tonnes of plastic enter the oceans every year and every bit of plastic ever manufactured still exists somewhere. The most significant impacts of marine plastic are often felt furthest from their point of origin. Scientists have observed plastic in the intestines of over 800 species, including whales, seals, fish, molluscs, even microscopic zooplankton have all been found to ingest microscopic plastic fragments. Zooplanktons are known to eat plastic, so does every other marine creature right up the food chain, increasingly damaging the endocrine of the animals ultimately reaching humans. Seabirds appear particularly vulnerable, with some estimates indicating that certain species, have as much as 90% plastic in their stomachs and intestines. Algae have an affinity with marine plastic and rapidly colonize floating pieces. Organisms appear to eat plastic because they are attracted by the chemical signature of the algae, deceptively signaling the presence of food. Algae emit dimethyl sulphate, critical in the formation of clouds and regulation of weather and climate.

PERSISTENT NATURE OF PLASTICS

Once thought to be degradable, plastics are very persistent as can be observed by brightly colored plastic debris, recovered from beaches being as old as 70 years. Plastic is not all visible, and neither does it float. Hence, obtaining a reliable estimate of total plastic volume in water is difficult. However, studies conducted in 2014 revealed an estimated quarter of a million tons of plastic, much of it in the form of rice sized grains and smaller, carried to even the remotest parts of the ocean by the water currents. The amount of plastic entering the ocean has been observed to double every 10 years, with half of all the present plastic in the ocean added in the last 15 years. Plastics produce a wide range of highly persistent endocrine disrupting organic chemicals during their transition in the marine environment, adding to the toxicity of the plastics themselves.

Getting rid of plastics is very difficult. Destruction of non-biodegradable plastics by incineration leads to the release of toxic carcinogenic chemicals such as dioxins, contributing to global warming. Moreover, recycling of plastics is difficult because different kinds of plastic have to be recycled by different processes and involve high costs as the value of the material is low.

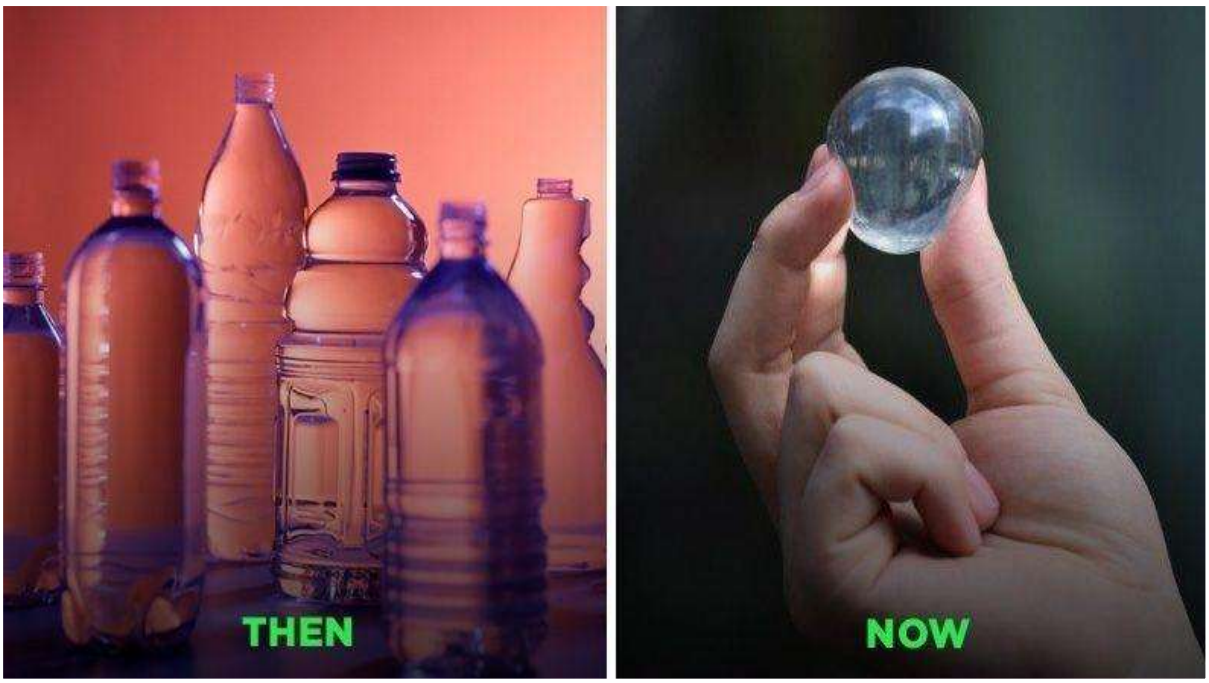
WHAT ARE BIOPLASTICS?

Bioplastics are plastics materials produced from natural renewable biomass sources, such as vegetable fats, oils, cellulose, corn starch, straw, woodchips, sawdust, recycled food waste, etc. It has been used as a base material for conversion into bio-based plastics, such as polylactic acid (PLA), polyhydroxyalkanoates, and starch-based bioplastic. Bioplastics present a biodegradable alternative to conventional plastics, thereby significantly reducing environmental strain and the use of fossil fuel reserves. Bioplastic can be made from agricultural by-products and also from used plastic bottles and other containers using microorganisms. These polyesters are known

as Polyhydroxyalkanoate (PHA), which is produced by fermentation of raw vegetable matters with a series of bacterial strains. In its natural form, this is similar to transparent film. Different bacteria produce different PHAs: they use different building blocks, and the composition of the PHA is controlled by an enzyme inside the bacteria, which is called polymerase. Hence, it is possible to produce different types of PHA based on feedstock used and bacteria.

ALGAL BIOPLASTICS

These are bioplastics made from a combination of biodegradable resins, plasticizers, and compatibilizers with algal biomass. The algal biomass can be cultured in ponds, or those present in wastewater treatment plants may also be a harvest for use as feedstock in bioplastic production. Materials derived from marine algae bioplastic go far beyond bags and bottles as the long chain organic polymers of seaweeds make them an ideal substitute for many material and fabric requirements. World leading vehicle manufacturer Toyota, in 2009 announced production of future car bodies from seaweed – based bioplastic, hoping to create a uniquely negative ecological footprint. The London based Skipping Rock Labs have developed a unique product named the Ooho. This is an edible globule of water in an enclosure made entirely from Sodium alginate, extracted from seaweeds. It is cheaper to produce than conventional plastic as well as being biodegradable in 4 - 6 weeks. This Ooho water bottles are actually, edible and they are tasteless, providing the opportunity for the production of flavoured edible bottles. Similarly, researchers in the Brittany based company Algopack, have devised and standardized the production of a wide range of algal bioplastics products capable of replacing almost all forms of plastics products.



OOHO – EDIBLE WATER BOTTLES

TECHNOLOGY

The bioplastic made from algae is expected to replace oil-based plastics. This can turn the industry from a producer of CO2 into a removal of greenhouse gas. This change is primarily because the algal bioplastic depends on the minute algae in the oceans which fix atmospheric CO2 form the atmosphere in the cells oil globules. The researchers have reported that any kind of object plates to furniture can be produced locally using 3D printers.

ALGAL BIOPLASTIC CREATED BY ERIC

The Dutch designers Eric Klarenbeek and Maartje Dros spent three years studying several organic resources like mycelium, potato starch, cocoa bean shells, and, more importantly, algae. Algae are highly effective biomass generators, generating starch through photosynthesis, releasing oxygen molecules into the atmosphere as a by-product. This starch is converted into the polymer through a chemical process that can be used in 3D printing. These biopolymer 3D-printers are called the 3D Bakery, which would mean that people could print their own environmentally friendly products. This polymer can be used to make anything from shampoo bottles to tableware or rubbish bins. Microalgae are mass cultured, harvested, dried, powdered, and incorporated in a blend with another biopolymer used as binders and natural additives. This mix is processed into a filament for 3D printing with an extruder. The designers have kept the exact formulation for the production of algal bioplastic a secret, but they have proved that the bioplastic can achieve different textures and colors. Presently spirulina, a blue-green microalga is being used due to the availability of spirulina farmers in the South of France. If the technology is as successful as it is being claimed, it will definitely provide the greenest of all bioplastics for the future of the planet.

ADVANTAGES OF USING ALGAE

- Algae has the highest growth rate of all plants
- Contains natural protein and carbohydrate-based polymers
- Can remediate Wastewater and CO2 emissions as a nutrient source
- Frequent harvesting and can be grown year around in warm climates
- Does not compete with Food production