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Bioplastic: A brief review

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ABSTRACT

Human dependence on plastics is increasing day by day that makes it an essential part of our life. A recent survey shows that about 1.27 billion people use and dispose plastics almost every day. In India total consumption of plastics is about 4 million tons and that makes it third largest plastic consumer in world. Plastic is an organic polymer. Petroleum is raw materials of plastic. Meanwhile, global petroleum reserves are diminishing. Petro-plastic is non-biodegradable that results in environment pollution. Fortunately, there are naturally-occurring compounds similar to those currently derived from petroleum. Advanced technology and the increasing need for eco-friendly products, have introduced us to a sustainable remedy, “Bioplastic” or “Smart plastic” Bioplastic is healthier alternatives to petroleum. Bioplastics are biodegradable and made from microbes, starch and cellulose that are renewable resources of energy. Bioplastics reduce consumption of fossil fuels and produces less green house gases so they are sustainable. Several attractive properties of bioplastics over petro plastic pull the attention of industries and researcher. This review will compare properties of petroleum-based to bioplastics and through light on different types of bioplastics is being introduced to the plastic industry.

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INTRODUCTION

Plastics are defined as “a group of materials, either synthetic or naturally occurring, that may be shaped when soft and then hardened to retain the given shape”. Plastics are polymers. A polymer is a substance made of many repeating units. Poly, meaning *many*, and *meros*, meaning *parts*. Plastics are synthesized from petroleum; however, reserves of petroleum are declining. It has been predicted that peak oil point in history at which petroleum extraction rate has reached the

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maximum, will fall between 2015-2025. Moreover, several foreign oil supplies concide with peteroleum plastic may deterious very slowly but as the Canadian plastic industry association admits it will never be completely eliminated. Due to its partial degradation some parts of it leach out and enter into food chains that result in hazards of human health and environment and eco balance is threatened. The attempt to recycle them by incineration step is producing hazards toxic chemical like dioxins, which may be carcinogenic as well as are affecting biota. Meanwhile, demand for plastics is increasing in global population. The bridge between supply and demand has vigilanted many research alternatives to petroleum plastics. Sustainable plastic or Bioplastic is originated from biomaterial and degraded by microorganisms. Biomaterial like microbes, cellulose, starch are used to make bioplastic which on degradation produce no carbon dioxide that result in no emission of Green-house gas in environment that make it sustainable and eco-friendly. On the other hand productions of it depend upon the renewable resources that may fulfill the present demand of population. The sustainable plastic products, bioplastic are preferred alternative to petroleum plastics. In the bioplastic lifecycle, CO_2 is both created and release within 1-10 years theoretically resulting in no CO_2 net gain or loss.

Bioplastics are used for disposable and non-disposable items. Such as packaging crockery, cutlery, bowls, straws and pots, medical implant (polylactic acid) which dissolve in the body, compostable film used in agriculture and coating for paper. They are also frequently used for trays, bags, fruit and vegetable containers and blister foils, egg cartons, meat packaging, vegetables, and bottling for soft drinks and dairy products, mobile phone casings, carpet fibers, insulation car interiors, fuel lines, and plastic piping. New electro active bioplastics that can be used to carry electric current are being developed. In these areas, the goal is to create items from sustainable resources.

SOURCE OF BIOPLASTIC

Microbes: A large number of microorganisum such as Sacchromyces cerevisiae, Zymomonas mobills, Clostridium, Acetobacterium, Bacillus coagulans, B.megatarium, Lactobacillus, Ralstonia etropha etc. are used for bioplastic formation. These microbes produced granules of size called inclusion body inside the cell membrane under limited condition of sulphtae and phosphate. These granules (inclusion body) are bioplastics.

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Starch-based plastics

Starch is a cheap source easily available from the potato. Starch having ability to absorb moisture. It is used in formation drugs capsules by pharmaceutical industry. The quality of starch based plastic. Can be improved by adding sorbital and glycerine.

Cellulose-based plastics

Cellulose bioplastic are mainly the cellulose esters (including cellulose acetate and nitrocellulose) and their derivative including celluloid.

Packing blister made from cellulose acetate.

Protein-based plastics

Different source such as wheat gluten and casein are used for formation of protein based plastics.

Some aliphatic polyesters

The aliphatic biopolyesters are mainly polyhydroxyalkanoates (PHAs) like the poly-3-hydroxybutyrate (PHB), polyhydroxyvalerate (PHV) and polyhydroxyhexanoate (PHH).

Poly-3-hydroxybutyrate (PHB)

The biopolymer poly-3-hydroxybutyrate (PHB) is polyester produced by bacteria cultivated on glucose, corn starch and waste water. Property of PHB similar to petroplastic. In addition biodegrable without residue. So useful for industrial scale.

Polyhydroxyalkanoates (PHA)

These are linear polymer (polyesters) produced in nature by bacteria such as *Ralstonia eutropha* under limited condition of sulphate and phosphate (fermented on sugar or lipid). These bioplastic are ductile, less elastic, and biodegrable.PHA has been degraded by a large numbers of microbes such as *Acidovorax faecalis, Aspergillus, fumigates,pseudomonas lemoigne, varivorax paradoxus,alcaligene faecalis, pseudomonas sp. And illyobacter delafieldi, comamonas, Pseudomonas stutzeri.* These are mainly used in medical industry.

Polylactic acid (PLA)

PLA is bioplastic produced from corn starch or dextrose.it is similar in characterstics to conventionl based mass plastic.it is used in plastic processing industry for production of film, containers, fibers, plastic,cups and bottles.

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Polyamide plastic

A variety of polyamide plastic PA11, PA12 and PA410 are obtained from natural oil.

PA11 superior than PA12 trade name Rilsan B which is not biodegrable, emission of green house gases and consumption of nonrenewable resources are reduced during its production. Beside it is thermo resistance. The main use of it in automobile fule lines, sports shoes electronic device component and in pneumatic airbrake tubing.

PA410 made from 70% castor oil trade name ecopax, high melting point, low moisture absorb, excellent resistance to chemical substances.

Bio-derived polyethylene/green polythene

Ethylene can be derived from ethanol which can be produced by agricultural feed stocks such as sugarcane or corn.

It is physically and chemically similar to traditional polyethene, nonbioderable, can be recycled and reduced green house gas emission. Its application inflexible packing and there product.

Genetically modified bioplastics

Genetic modification (GM) is that derived from GM plant and GM microorganisum to improve quality and efficiency of bioplastic.

Polyhydroxyurethanes

It is biobased and isocyanate-free polyurethanes produced by spontaneous reaction between polyamines and cyclic carbonates. It can be recycle and reprocess through dynamic transcarbamoylation reactions.

Bio-plastics future and challenges

Alongside the bird's eye view, there were several talks about innovation. From Sweden, Sekab presented its "Locally Grown Plastics" project, which looks into making polyethylene from forest residues. The demand for this biomass has gone down. FKuR Kunststoff (Germany) shared its work on developing partially biobased PP, a cheap polymer with a huge market, and the niche polymer TPE. BASF showcased the many uses of ecovio, a blend of corn-based PLA and a fossil-based biodegradable polymer. This year's star application seems to be a styrofoam-like material, sold to its industry buyers as an expandable bead – behaving somewhat

like popcorn. DuPont, from a type of industrial corn from engineered bacteria that isn't used for food. This year, Corbion decided to highlight its PLA root trainer i.e is a plastic cone used in young rubber plants and decomposes in the soil and doesn't need to be removed when the rubber plant is transplanted, reducing damage to the roots and significant losses in plantations. Alexis Roma (from Renault) use of bioplastics in the car industry to replace other heavy materials and have better fuel economy.

Bioplastics with its innovative properties competing with fossil plastics. Globally, production of bioplastics reached about 4.1 million tons in 2016 that is 5% more than the previous year. Likewise positive prediction for the next 5 years. Beside it, main debating issues in use of bioplastics are food vs feed, biodegrablity & compostability and recycling.

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