BIO DEGRADABLE POLYMERS-BIOPOLYMERS

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Every biopolymer has its own material specific properties, e.g. barrier properties such as oxygen permeability in thermoplastic starch. The barrier properties are relevant to the choice of biopolymers for the packaging of particular products. Poytydroxibutyrate made by varying the nutrient composition of the bacteria during fermentation of starch, decompose harmlessly in the human body and have therefore long been used for medical applications and hence are widely used in surgical implants. Polylactides (lactic acid polymers) are made from lactic acid, which is in turn made from lactose (or milk sugar) obtained from sugar beet, potatoes, wheat, maze etc. Polylactides are water resistant and can be formed by injection moulding, blowing and vacuum forming. Bioplastics have very promising prospects for use in pesticide soil pins, for packaging in-fight catering products and for packaging dairy products. Biopolymers could also prove an asset to waste processing. Biopolymers have been shown to degrade 10 to 20 times faster than traditional plastics without leaving hazardous materials. They are biocompatible, eco friendly materials which may be tailored to specific needs. Environmental responsibility is constantly increasing in importance to both consumers and industry .

Introduction

The exponential growth of the human population has led to the accumulation of huge amounts of non-degradable waste materials across our globe. The presence of non-biodegradable residues is affecting the potential survival of many species in the biosphere. Conventional synthetic plastic and polymeric products such as polyethylene and polypropylene persist for many years after disposal and constitutes significant portion of the total municipal solid waste generated in different countries (Tharanathan, R.N 2003). Garbage containing plastics needs large landfill lands for proper dumping while burning of plastics may emit toxic gases viz. dioxin, furans, carbon mono oxide etc. Plastic waste presents challenges and opportunities to societies regardless of their sustainability awareness and technological advances. In a society based on reduce, recover, regenerate, recycle and reuse (5 R's) aspects for environmental sustainability, innovative processes of waste handling and managing techniques may be used to minimize the adverse implications of plastic waste. For this reason, several researches have been targeted to develop eco-friendly and bio-degradable polymeric materials that can be readily eliminated from the biosphere, and have designed novel strategies aimed for tailor made applications. Bioplastics are manufactured using biopolymers which are present in, or Created by, living organisms (BÍsmarck, A et al 2002). These include polymers from renewable Sources that can be polymerized to create bioplastics and are biodegradable. Biodegradable polymers disposed in bioactive environments degrade by the enzymatic action of microorganisms such as bacteria, fungi, and algae (Chandra, R et al 1998). Their polymer chains may also be broken down by nonenzymatic processes such as chemical hydrolysis. Biodegradation Converts them to C02, CH4, water, biomass, humic matter, and other natural substances. Bioplastics are thus naturally recycled by biological processes. It is also a fact that few bioplastic may be degradable but not biodegradable or it may be biodegradable but not compostable (that is ,it's break down too slowly to be called compostable or leaves toxic residue) (Huang, J.C et al 1990).

Some Biopolymers as Bioplastic:

Poly-lactic acid (PLA) is a polyester made up from lactic acid. It is a transparent bioplastic used for non-medical applications such as packaging (film, thermoformed containers, and short-shelflife bottles). PLA degrades primarily by hydrolysis and can be converted into compost in municipal compost facilities. Poly(?-caprolactone), PCL, is a thermoplastic biodegradable polyester synthesized by chemical conversion of crude oil, followed by ring-opening polymerization. PCL has good water, oil, solvent, and chlorine resistance, a low melting point, and low viscosity, and is easily processed thermally. To reduce manufacturing costs, PCL may be blended with starch-for example, to make trash bags. By blending PCL with fiberforming polymers (such as cellulose), hydroentangled nonwovens (in which bonding of a fiber web into a sheet is accomplished by entangling the fibers by water jets), scrub-suits, incontinence products, and bandage holders have been produced. The rate of hydrolysis an biodegradation of PCL depends on its moleaular weight and degree of crystallinity. However, many microbes in nature produce enzymes capable of complete PCL biodegradation (Salmoral E. M. et al 2000).

Poly-3-hydroxybutyrate (PHB) are polyester produced from renewable raw materials. Their characteristics are similar to those of petrochemical plastic. It produces transparent film at a melting point higher than 1300 and is biodegradable without residue. Polyamide 11 (PA 11) is also-a biopolymer derived from vegetable oil. PA 11 is not biodegradable. It is used in high performance applications -automotive fuel lines. Pneumatic airbrake tubing, electrical anti-termite cable sheathing, oil & gas flexible pipes & control fluid umbilicals, sports shoes, electronic device components, catheters, etc. Carboxymethyl Cellulose (CMC), Hydroxyethyl cellulose (HEC), Poly(aspartic acid) and Poly-(glutamic acid) are known as Water soluble polymers which have been applied as detergent builders, scale inhibitors, flocculants, thickeners, emulsifiers, and paper-sizing agents. They are also found in several household articles such as, cleaning products, foods, toothpaste, shampoo, conditioners, skin lotions, and textiles. The largest volumes of water-soluble polymers are prepared from acrylic acid, maleic anhydride methacrylic acid, and various combinations of these monomers. With the exception of their oligomers, these polymers are not biodegradable. Polymers(vinyl alcohol) is the only water soluble polymer that is regarded as biodegradable and is currently used in textiles, paper and packaging industries, as paper coatings, adhesives, and films (Simon, J. et al 1998).

Bioplastic: Market Trend and Future Aspects

Application of bioplastic in manufacture of variety of household, biomedical and industrial items are increasing due to the low Cost of raw material . The worldwide consumption of biodegradable polymers has increased from 14 million kg in 1996 to an estimated 68 million kg in 2001 (Fomin, VA 2001). It is estimated that the end of the 20th century saw the worldwide production of synthetic plastics reach 130 million t/year, while the demand for biodegradable plastics is reported to be growing by 30% each year (Leaver such 2004; Schroeter, J. 1998). Target markets for bioplastic include packaging materials (trash bags, wrappings, loose-fill foam, food containers, film Wrapping, laminated paper), disposable nonwovens (engineered fabrics) and hygiene products (diaper back sheets, cotton swabs), consumer goods (fast-food tableware, containers, egg cartons razor handles, toys) and agriculture tools (mulch films , planters).For future growth, efforts are needed to develop infrastructure for the proper disposal of bioplastic in bioactive environments. It is also need to reduce costs of bioplastic finished products by using cost effective and eco friendly plastic additives vz. Sorbitol as plasticizer, natural colour and dyes instead of synthetic pigments containing heavy metals and harmful organic residues.

Environmental Impact of Bioplastic and Sustainability

Biodegradable polymers are designed to degrade upon disposed by the action of living organism (Chau, H et al 1999). Extra ordinary progress has been made in the development of practical processes and products from polymers such as starch, cellulose and lactic acid (Grigat, E. et al 1998). Biodegradable polymers disposed in bioactive environments degrade by the enzymatic action of micro-organism such as bacteria, fungi, and algae (Orhan, Y et al 2000; Park, S.Y et al 2001). The polymer chains may also be broken down by non enzymatic processes such as chemical hydrolysis. Biodegradation converts them to carbon dioxide, methane, water, biomass, humic matter and other natural substance. Since there is an abundant amount of waste in the world, there has been a lot of interest in research devoted to the creating of bioplastic having biodegradable materials. There are many advantages to creating the biodegradable plastics. Starch-based plastics have been proved to be more environmentally friendly which degrade 10 to 20 times faster than traditional plastics (Gross, R.A, et al 2002). Biodegradable plastics have been proved to improve soil quality (Nakasaki, K. et al 2000). This process is performed as the microorgarisms and bacteria in the soil decompose the material, and it actually makes the ground more fertile. Few bioplastics whish are not biodegradable or compostable do not adversely affect the surrounding environment if discarded indiscriminately. The development of bioplastic can be also considered in context of the renewable alternative of green chemistry. Bioplastics need to derive more carbon for chemical processes from renewable substances instead of oil reserves, to develop cleaner chemical processes, and to avoid perturbing the ecosystem. This process is helpful in effective utilization of renewable feedstocks and biomass, Which in turn results in reduction in the application of petroleum by-products and emission of fossil fuel-derived CO2. Thus application of bioplastic is becoming an essential tool to establish the concept of green globe and environmental sustainability.

Conclusion

Biopolymers are natural products that are synthesized and catabolised by different organisms and that have found broad biomedical and biotechnological applications. They can be assimilated by many species (biodegradable) and do not cause toxic effects in the host (biocompatible) conferring upon them a considerable advantage with respect to other conventional synthetic products. Bioplastics are a special type of biomaterial with tailor made applications.

The commercialisation of cost effective bioplastic articles having relatively short-use lifetime is needed to generalize their application in society. A holistic effort and innovative research is also necessary for suitability assessment of bioplastic finished products to improve their biocompatibility, tensile strength and degradation mechanism. Bioplastic industry has a positive future, driven mainly by the environmental benefits of Using renewable resource feedstock sources. Mass awareness programme and collaborative research is essential for development and commercialization of bioplastic with optimum technical performance, and full biodegradability for sustainable future.

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