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BIOPLASTICS ROLE OF THE PROTECT OUR ENVIRONMENT

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ABSTRACT

Bioplastic simply refers to plastic made from plant or other biological material instead of petroleum. It is also often called bio-based plastic. The production of plastics, which needs to use raw material and is difficult to regenerate, has grown up a lot lately. Each year, over 70 millions tones of polymers areproduced and they end up in waste deposits. Plastic production has high costs and theirperiod of time to biodegrade is very long, harming the environment. Bio plastic is composed of biopolymers produced by living organisms. They are generally made up of monomer units of nucleic acid, amino acids and sugars. Leading chemists are now taking the initiative to change modern day chemistry to help protect our environment without changing the lifestyles that everyone has become accustomed to. Some biopolymers viz. cellulose, Polylactic acid (PLA), naturally occurring starch based polymers and Poly-3-hydroxybutyrate (PHB) can be used as plastics, replacing the need for polystyrene or polyethylene based synthetic plastics. 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. This effort will be helpful in waste minimization, recycle and reuse of enormous biomass viz. agricultural waste as well as reduction in pollution load which are essential demand of a sustainable society and clean climate.A lot of methods to produce plastic was and is still being looked for to protect the environment. One of them is to produce the biodegradable plastic based on starch, protein composites. The paper presents the characteristics of raw materials, the technologies of producing and of using the bioplastics.

KEYWORDS: *Bio-plastics, Biopolymer, Packaging, Biocompatibility, Cost-Effectiveness, Clean Climate.*

INTRODUCTION

Sustainable development is now accepted by governments, industry and the public as a necessary goal for achieving societal, economic and environmental objectives. In today's society it seems that the world chemistry is admired by few and frowned upon by many. Chemistry is not only thought of as extremely difficult academic disciple, but it is viewed as one of main culprits in the phenomenon known as global warming. Many global warming activists, along with the general media, stress the importance of a greener world without the use of synthetically derived chemicals. There is no denying that chemistry has had many negative impacts on our planet; however, it seems many individuals have forgotten that the science of science of chemistry has also made many beneficial contributions to our civilization. As a society we quick to criticize and point to blame, but maybe we should remember how important chemistry is as we take our daily medications, drink our coffee, and pick up our dry-

cleaning.

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. Bio plastics are manufactured using biopolymers which are present in, or created by, living organisms (Bismarck, A *et al* 2002). These include polymers from renewable sources that can be polymerized to create bio plastics and are biodegradable.

BIODEGRADABLE PLASTICS

Biodegradable plastics are becoming a new trend because they are believed to be friendlier to our environment. Biodegradable plastics are plastics that will decompose in both aerobic and anaerobic environments. Unlike conventional plastics, "a genuine biodegradable plastic will beconverted to carbon dioxide, water and compost, without leaving any persistent or toxic residue"(Unmar&Mohee, 2008). Biodegradable plastics have the ability to significantly decrease the quantity of plastics within our landfills, and also eliminate toxins within our air from the burning of conventional plastics (Unmar&Mohee, 2008). Biodegradable plastics are made from renewable raw materials, and are presently found invarious forms with different degrees of degradability. One of the most frequently used forms of biodegradable plastics is termed as *hydro biodegradable plastic*. Unlike conventional plastics, which are comprised of polymers of high molecular weight, these hydro biodegradable plastics are comprised primarily of starches that are found in plants or food, although some contain a small percentage of synthetic polymers. When hydro biodegradable compounds are degraded, the original product reduces to water, Carbon dioxide, methane, and biomass (Azios, 2007). Although methane and carbon dioxide are considered greenhouse gases, this additive effectupon the cumulative level of the planet's greenhouse gases is considered to be negligible by most researchers. This is because landfills are specifically designed to capture any released methane, so any methane released will be confined within the land fill. The carbon dioxide that is produced is also not looked at as a contributor of greenhouse gases because the plant that the hydro biodegradable plastic was made from consumed carbon dioxide, so the release of carbon dioxide during the decomposition is thought of as an even exchange (Azios, 2007). However, there are many other forms of biodegradable plastics that are still made exclusively from non-renewable petroleum by-products, similar to conventional plastics. This form of biodegradable plastic is termed *Oxo biodegradable*. The primary difference between Oxo biodegradable plastics and conventional plastics is that these products degrade more quickly. Oxodegradable plastics break down into water, carbon dioxide, and biomass when exposed tosunlight, heat, and other stresses. Oxo biodegradables do break down much quicker than conventional plastics, but they still require the same fossil fuels during their manufacture and emit the same degree of greenhouse gases as conventional plastics (Azios, 2007).

Types of Bio Plastic on the Basis of their Origin

Bio plastic are special type of biomaterial composed of variety of biodegradable polymers originating from different sources and materials (Table 1).

Starch Based Plastics

Starch is a cost effective, easily available, annually renewable material derived from corn, wheat, potatoes, rice and other crops. Starch contains amylase and amylopectin, at ratios that vary with the starch source. This variation in polymer units provides a natural mechanism for regulating starch material properties (Jopski, T 1993; Martin, O*et al* 2001). Starch when harvested is turned into a white, granular product. Biodegradable starches can be processed using conventional plastic technologies such as injection moulding, blow moulding, film blowing, foaming, thermoforming and extrusion (Lorcks, J. 1998). The process changes the starch from a lactic acid monomer into a polymer chain called polylacitide (PLA) or polygloycolic (PGA). Both PLA and PGA are crystalline polymers and effectively used for synthesis of bio plastics. Starch based plastics constitutes about 50 percent of the total bio plastic market. Starch is used for many non-food items such as making paper, cardboard, textile sizing, and adhesives. Starched based plastics have already been processed into eating utensils, plates, cups and other products. Starched based plastics have ability to absorb humidity, hence are widely applied for production of drug capsules (Ledward, D.A. 1998).

Bacteria Based Plastics

Bacteria are used to create a different type of biodegradable plastics using the polymer chain polyhydroxyalkanoate (PHA). PHA is produced inside bacteria cells. The bacteria are harvested after they are grown in the culture, and then created into biodegradable plastics. The mechanical properties of their resins can be altered depending on the needs of the product. Development of PHA materials in nonwoven biodegradable polyesters meant for disposable products such as drapes, gloves and surgical gowns, which may be thrown away after one use. The PHA fibers may also degrade aerobically and an aerobically, can be digested under alkaline conditions (Frisoni, G*et al* 2001).

Soy Based Plastics

Soy based plastics use another renewable alternative material used for biodegradable plastics. Soybeans are composed of protein with limited amounts of fat and oil. Protein levels in Soybeans range from 40-55%. The high amount of protein means that they must be properly plasticized when being formed into plastic materials and films. Thebio plastic films produced are used for manufacture of food coatings, freestanding plastics (used for bottles), automobile parts etc.

Miscellaneous Biopolymers for Bio Plastic

Poly-lactic acid (PLA) is a polyester made up from lactic acid. It is a transparent bio plastic used for non-medical applications such as packaging (film, thermoformed containers, and short–shelf lifebottles). PLA degradesprimarily by hydrolysis and can be converted into compost in municipal compost facilities. Poly (ε-caprolactone), *PCL,* is a thermo plastic biodegradable polyester synthesized by chemical conversion of crude oil, followed by ring-openingpolymerization. PCL has good water, oil, solvent, and chlorine resistance, a low meltingpoint, and low viscosity, and is easily processed thermally. To reduce manufacturing costs, PCLmay be blended with starch-for example, tomake trash bags. By blending PCL with fibreformingpolymers (such as cellulose), hydro entanglednonwovens (in which bonding of a fibre web into a sheet is accomplished by entanglingthefibres by water jets), scrub-suits, in continence products, and bandage holders have been produced. The rate of hydrolysis and biodegradation of PCL dependson its molecular weight and degreeofcrystallinity. 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 130^0C 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 umbilical, 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 detergentbuilders, 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 fromacrylic acid, maleic anhydride, methacrylic acid, and various combinations of the semonomers. With the exception of their oligomers, these polymers are not biodegradable. Poly (vinyl alcohol) is the only water soluble polymer that is regarded as biodegradable and is currently used in textiles, paper andpackaging industries as paper coatings, adhesives, and films (Simon, J. *et al* 1998).

Bio Plastics and Bio-Economy

Bio plastics are an integral part of the green chemistry sector. They offer manifold market opportunities as major outlets for renewably sourced chemicals for innovative high-tech as well as mass-market applications. Plastics are indispensable in our daily life. Approximately 265,000,000 tonnes of them are produced and used annually. Today, bio plastics from renewable resources only account for a very small share of the total market (<1 percent), but the rapid advances in biotechnology and biochemistry will further push forward this fast growing market. To the present day, bio plastics production capacities have already expanded with double-digit growth figures every year. Innovative technological approaches like the bio refinery and the concept platform chemicals will further transform industrial production of renewable plastics.

Bio Plastics - Technology Overview

The majority of today’s available production technology for green chemicals and plastics is based on the use of plants rich in carbohydrate. Cereals (e.g. corn), starch plants (e.g. potatoes, tapioca), sugar-rich plants (beets, cane), or oil plants (e.g. rapeseed, sunflower) provide the basis to process feed stocks. In future, the bio plastic industry aims to further apply fermentation technologies that allow for the utilisation of other biogenic input based on non-food crop sources. In particular, the production of cellulosic sugars and ethanol’s is regarded a very promising technological approach.

Bio Plastic: Advantages and Biocompatibility

Bio plastic and biopolymers has several advantages over conventional synthetic plastic. Like it reduce the pollution (toxic emissions) and environmental damage as well as degradation of biodegradable polymers produces acidic intermediates, which neutralize the ammonia content, thus reduceodour problems. Bio plastic has also proven its applicability in biomedical sector (Swift, G. 1998). Biodegradable polymers has shown potential for use in intracellular delivery and sustained release of therapeutic drugs to the acidic environments of tumors, inflammatory tissues and intracellular vesicles that hold foreign matter. Degradation of the biopolymer in a living system does not produce inflammation-causing acid, but instead generates membrane-permeable products that allow all of the polymer's byproducts to diffuse outside the cell. That means byproducts shouldn't accumulate in a patient's tissue and cause in flammation. The greatest advantages of using biopolymers derived plastic articles from renewable feed stocks are their low cost (Narayan, R.*et al* 1999). Natural fibers are advantageous over synthetic one because they are less expensive and more readily available (Tharanathan, R.N 2003). The expansion of flax fiber incorporation in to automobile parts is a positive development for Canada’s agriculture industry, particularly in its diversification efforts. Another application of natural fiber reinforcement has been developed in the china reed fiber to reinforce transport pallets.

Table 1 Biopolymers Used for Preparation of Bio plastic

Sr. No.	Biopolymer	Natural Sources	Properties
1.	**Biopolymers from Living Organisms**		
	Cellulose	Wood, cotton, corn, wheat etc.	The polymer is made up of glucose. It is the main component of plant cell walls.
	Soy Protein	Soybeans	Protein which naturally occurs in the soy plant
	Starch	Corn, potatoes, wheat, tapioca etc.	This polymer is one way carbohydrates are stored in plant tissue. It is a polymer made up of glucose. Absent in animal tissues.
	Polyesters	Bacteria	These polyesters are created through naturally occurring chemical reactions that are carried out by certain types of bacteria.
2.	**Polymerizable Molecules**		
	Lactic acid	Beats, corn, potatoes and others.	Produce through fermentation of sugar, feedstock such as beats, and by converting starch in corn, potatoes or other starch sources. It is polymerized to produce polylactic acid, a polymer that is use to produce plastic.
	Triglycerides	Vegetable oils	These form a large part of the storage lipid found in plant and animal cells. Vegetable oils are one possible source of triglycerides that can be polymerized into plastic.

CONCLUSION :-

Biomaterials 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. Bio plastics are a special type of biomaterial with tailor made applications. The commercialization of cost effective bio plastic 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 bio plastic finished products to improve their biocompatibility, tensile strength and degradation mechanism. Bio plastic 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 bio plastic with optimum technical performance, and full biodegradability for sustainable future.

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