NATURE FRIENDLY PLASTICS

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Abstract

In recent years bio-fibres have attracted increasing interest due to their wide applications in food packaging and in biomedical science. These eco-friendly polymers will replace the use of the petroleum based synthetic polymers due to their safety and biodegradability. Many such polymers are being synthesized to control environmental pollution. This paper reports the production and properties of cellulose acetate (from flax fibres and cotton linters) and medium chain length poly hydroxy alkanoic acids. Medium chain length, Poly Hydroxy Alkanoic acids (mcl-PHAs) are the polyesters which are accumulated by few bacteria. These are biodegradable. Recombinant bacteria technology is used for their preparation. Now a days, Scientists are focussing on optimized bacterial mcl-PHA synthesis on inexpensive agro-substrate and the development of plant based mcl-PHAs in the coming years. Slowly these bioplastics will be produced in bulk for future applications.

Introduction

Biodegradable polymers helps us for waste management treatment over traditional plastics. These options include composting of domestic and municipal waste instead of landfills, which is the worst disposal option. Therefore, biodegradable polymers can make significant contributions to material recovery, reduction of landfill and utilization of renewable resources. Biodegradable plastics, based on cellulose acetate, were studied and found that these plastics decomposed in soil or water within a few years. This material can be incinerated without residue. Cellulose acetate could be used for the manufacturing of photographic films, ultra-filteration membranes, fibres and some plastic tools. Another example is medium chain length Poly Hydroxyl Alkanoates, which have been marketed as environmental friendly bio-plastics with less carbondioxide emission. Many researchers used acetylation of plant cellulose fibre, such as rice, wheat, barley straws and cotton by-products. Because the raw materials have a high impact on the cost of bio-based plastic production hence the use of low cost cellulosic raw materials is attractive for the preparation of cellulose acetate. Biodegradable plastics, especially based on renewable resources from the agricultural industry is essential and important innovation. This innovation offers substantial impulse for the future technologies. Presently we are using large amounts of non-biodegradable plastics, which are the main source of soil pollution on the earth. Government and many non- government organizations are active now a days to control this pollution. As in the modern era of technology and globalization, a world free from plastics is not possible because these plastics are used everywhere from houses to offices, industries, packaging material etc. They have become an important part of our modern lifestyle, so we must search for their biodegradable alternatives, which are affordable too so that we can enjoy their benefits without affecting our progress rate.

Prepration and Properties of Cellulose Acetate derivatives

Flax fibres are cleaned by removing wax, fats and dust from it. The cotton linters are washed with water and bleaching is done with bleaching agent (5% NaOCl and 5% NaOH). Acetic anhydride, Glacial Acetic acid and Sulphuric Acid were mixed and the mixture was cooled to 7^o C. Flax fibres or cotton linters were added slowly to this mixture with agitation to bring about the acetylation. The resulted cellulose acetate was hydrated by using a specific mixture of acetic acid and sulphuric acid. Then the product was allowed to age for 15 hours. After centrifugation plasticizers were added and acetone was used for dilution. Then the product was poured into a mould or on smooth surface for shaping. The final product have been tested by FTIR, GPC and XRD. Its biodegradability was tested by various methods like composting, Bench-scale simulated composting etc.

Preparation and Properties of PHAs

PHAs are prepared by using living organisms like plants and bacteria. As high concentrations of the polymer inside the plant cell have negative effect on the growth of plant, hence low yields of PHAs can be prepared by using plants. In contrast, 90% of the dry cell mass of polymer can be accumulated in bacterial cell. Bacteria store carbon and energy in the form of PHAs, when nutrient supplies are imbalanced. Further when nitrogen, phosphorous and oxygen supplies are limited, the polyesters accumulate within the bacterial cell as granules because they are water insoluble. The surface of PHA granule is coated with a layer of phospholipids and proteins. Phasin is a class of protein which is found at the interface of granules. The first PHA to be discovered, hence most studied is PHB. In the first step of its synthesis 3-Ketothiolase combines with two molecules of acetyl Co-A to form Acetoacetyl- CoA. An enzyme Acetoacetyl- CoA reductase, allows the reduction of Acetoacetyl- CoA to 3- Hydroxy butyryl CoA. In the final step, PHB Synthase enzyme polymerizes 3- Hydroxybutyryl CoA to PHB and CoA is liberated. Various bacterial cultures used for its prepration are *Cupria vidus, Aeromonas hydrophila, Bacillus cereus* etc.

Bacteria produced PHAs have average mass of 4.0X 10^6 Da with a polydispersity (Mw/Mn) of around 2.0. The material characteristics of these bio-polymers are similar to conventional plastics such as polypropylene. PHB homopolymer is highly crystalline, stiff and brittle material. When spun into fibres, it behaves as hard elastic material. But co-polymers like PHBV or mcl-PHAs are less stiff than PHB. Its most important characteristic is its biodegradability. Micro-organisms in nature are able to degrade PHAs by using PHA hydroxylase and PHA depolymerises. The activities of these enzymes depend upon the polymer composition and environmental conditions and may take few months to years for degradation. These have numerous medical applications as they are biocompatible and does not need to be removed when used as bio-implants.

A lot of jobs and a potential market of more than one million tonnes a year for biodegradable plastics in Europe is proposed by EU Commission Directorate General XII. Starch is a natural biodegradable polymer. Bioplastics based on starch use the benefits of natural polymerization and the availability of raw materials and process technology. Thermoplastic starch and others blends of thermoplastic starch with hydrophobic attatchments are in biotech research now. Many production programs have been designed for their economic synthesis. Latest development results are reaction compounding process technologies to produce thermoplastic starch derivatives by continuous extrusion process, in which film extrusions and injection mouldings are used. Many bioflex films have been prepared by these processes. The bioflex films have mechanical properties as they are opaque to transparent, printable, shrinkable and can be colourized. Such films are permeable to vapours and has good barrier properties to oxygen. Bags and other materials can be made from these, which can be further used in the same way as conventional foils are used for packaging, for garbage bags, shopping bags, food wrapping and many more agricultural, industrial and technical uses. They are very safe because they are 100% biodegradable and compostable. The innovation of this technology is an excellent example of sustainable development, which means responsible use of available natural resources and production processes that take environmental aspects and pollution problems into consideration. Many other natural fibres along with starch are also used to make bioplastics e.g. hemp, flax, ranie, etc. These are used to prepare biocomposites that are comparable to the well-known glass fibre reinforced compounds. They are completely biodegradable.

Conclusion

The environment friendly Cellulose Acetate and Poly Hydroxy Alkanoates are prepared successfully and have been characterized by using various instrumental techniques and environmental properties tests. Both were found to be biodegradable, hence they are suitable for packages, containers, fibres and plastic tools. These have potential to replace or minimize the use of non-biodegradable and petroleum based materials.

References : *Bernard Witholt, Birgit Kessler Elsevier(1999), Jurgen Lorks(Elsevier, Jan, 1998), A. S. Herrmann, J. Nickel, U. Riedel, T. Seidenstucker, H. G. Fritz N. A. Mostafa, M. Tayeb, Y. Cao J Wu T. Meng , J. Zhang J. S. He, C. A. Cateto, M. F. Barreiro , A. E. Rodrigues , G. Davis, Peter and Rehm , Potter et al , Agus et al*