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Research Paper Engineering

Biopolymers

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ABSTRACT

Biopolymer means a substance able to be broke down into other substances with a significant change in chemical structure by the activities of living organisms and is therefore unlikely to persist in environment.

INTRODUCTION

Bioplastics are environmentally friendly because,

- less emission of carbon dioxide
- reduce global warming.
- Biodegradable - material returns to its natural state

After their uses if biopolymers are subjected to enzymes attack under controlled environment, enzymes breaks the starch from biopolymer and produce lactic acid which is further polymerised to produce Polylactic acid. This Polylactic acid is further used for manufacturing of new biopolymer products. Thus biopolymer is recycled and reused.

APPLICATIONS

Packaging

- shopping bags
- Trays and containers for fruit, vegetables, eggs and meat
- bottles for soft drinks and dairy products
- blister foils for fruit and vegetables

Catering products

- Disposable crockery and cutlery
- pots and bowls
- pack foils for cooked food
- straws

Gardening

- Mulch film –used for plant harvesting. Once the stem comes out of soil, the film will degrade by application of chemicals and enzymes. This will prevent the manual collection of film after use.
- Plantable pots- used for planting small herbs. Once the plant starts growing by applying microbial attack pot will decompose into soil leaving the plant behind.

Medical

- The bio textile implant is used in soldier joint surgery. Once the bone is healed, the implant will decompose into the body.
- During spine surgery biopolymer is used for joining as screws which degrades after certain time as the joints are healed.

Automobile

Shefield Technoplast is working on a project for manufacturing biocar. They use natural fibres extracted from Palm oil. This fiber is synthesized with resin to create rigid strong waterproof substance for manufacturing car. As the lifespan of car is over, synthetic resin is removed from it and recycles. The expected lifecycle for this car is eight years.

EXAMPLES & CLASSIFICATION OF BIOPOLYMERS

Some Biopolymer examples are:

- Proteins
- Carbohydrates
- DNA
- RNA
- Lipids
- Nucleic acids
- Peptides & Polysaccharides (such as glycogen, starch and cellulose)

BIOPOLYMER CLASSIFICATIONS

There are four main types of Biopolymers.

Sugar based Biopolymers

Starch or Sucrose is used as input for manufacturing Polyhydroxibutyrate. Sugar based polymers can be produced by blowing, injection, vacuum forming and extrusion. Lactic acid polymers (Polyactides) are created from milk sugar (lactose) that is extracted from potatoes, maize, wheat and sugar beet. Polyactides are resistant to water and can be manufactured by methods like vacuum forming, blowing and injection molding.

Starch based Biopolymers

Starch acts as a natural polymer and can be obtained from wheat, tapioca, maize and potatoes. The material is stored in tissues of plants as one way carbohydrates. It is composed of glucose and can be obtained by melting starch. This polymer is not present in animal tissues. It can be found in vegetables like tapioca, corn, wheat and potatoes.

Biopolymers based on Synthetic materials

Synthetic compounds that are obtained from petroleum can also be used for making biodegradable polymers such as aliphatic aromatic copolyesters. Though these polymers are manufactured from synthetic components, they are completely compostable and bio-degradable.

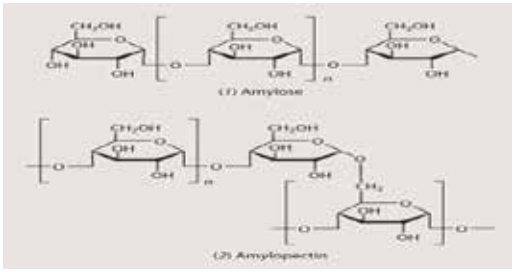
Cellulose based Biopolymers
These are used for packing cigarettes, CDS and confectionary. This polymer is composed of glucose and is the primary constituent of plant cellular walls. It is obtained from natural resources like cotton, wood, wheat and corn.

The production of biopolymer may be done either from animal products or agricultural plants.

Biopolymer Environmental Benefits
Some of the environmental benefits of this polymer are:

- These polymers are carbon neutral and can always be renewed. These are sustainable as they are composed of living materials.
- These polymers can reduce carbon dioxide levels in the atmosphere and also decrease carbon emissions. This happens because bio-degradation of these chemical compounds can release carbon dioxide that can be reabsorbed by crops grown as a substitute in their place.
- It is also compostable which means there is less chance of environmental pollution from this compound. This is one of the primary advantages of this chemical compound. However, the materials composed from this compound are not compostable.
- These chemical compounds reduce dependency on non-renewable fossil fuels. These are easily biodegradable and can decrease air pollution. It greatly reduces the harmful effect of plastic use on the environment. Long term use of biopolymer use will limit the use of fossil fuel.

Manufacturing Biodegradable film
Ingredients- Starch



Main hydrocarbon resource found in cereal and tuber plants such as maize and potato.

Main components of starch are linear amylose and highly branched Amylopectin composed of glucose units. Amylopectin forms lamellar structure consisting of crystalline zone and amylase are randomly joined forming amorphous zone. To break the bonds of crystalline zones HCL is added.

Potato Starch
Potato containing starch (leucoplast) is crushed so starch will be released from destroyed cells. This starch is further washed and dried to get potato starch for further processing.

Characteristics of potato starch :
- oval spherical granules
- size ranges between 5 and 100 µm.
- very refined starch, containing minimal protein or fat.
- powder has a clear white colour,
- high binding strength, long texture and a
- minimal tendency to foaming or yellowing of the solution.

Potato starch contains approximately 800 ppm phosphate bound to the starch; this increases the viscosity , gives the solution a slightly anionic character, low gelanisation temperature (approximately 140 °F (60 °C) and high swelling power.

Polyols
Monosaccharide based polyols such as glycerol, sorbitol are used as plasticizers in film because of their plasticization ability due to low molecular weights.

Plasticizer is added to the biopolymer to give
- Better handling properties like flexibility and elasticity.
- Descreases interaction between biopolymer chains such as amylose and Amylopectin thus preventing close packing which results into lower degree of crystallization. Pores and cracks should be prevented by using plasticizers.

Process Steps:
Batch 1
- Potato strach is added in boided water and mixed thoroughly.
- Ethylene glycol and HCl is added to starch.
- The PH balance of solution is done through adding drops of NaOH
- Then solution is boiled and film is sprayed over glass and put for curing.

Batch 2
- Potato starch is dissolved in HCl so bonds of Amylopectin breaks easily.
- Water is boiled and glycerin is added. It is mixed with starch and HCL solution.
- NaOH is added to balance the PH (upto 7)
- Solution is boiled for 15 minutes and film is sprayed over glass and allowed to cure.

Batch 3
- Potato starch is dissolved in HCl so bonds of Amylopectin breaks easily.
- LDPE and starch are mixed & allowed to cure.

Result:

Comparison of biodegradability for various batches:

Batch	Biodegradability measured in terms of weight in gms		
	Initial	after 21 days	after 42 days
1	3.70	1.85	1.60
2	2.70	1.75	1.50
3	3.60	2.88 (after 180 days)	

Conclusion:
Biopolymer made from higher starch rate promotes brittleness and results into lower strength and modulus. By blending it with polymer the strength and modulus increases causing decreasing rate of biodegradation. Proper blending of starch and polymer can give product higher strength & better biodegradability. By blending LDPE with starch the strength increases along with modulus and biodegradability of LDPE is 20% by weight after 360 days. So by blending it with starch the % of biodegradability can be increased.

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