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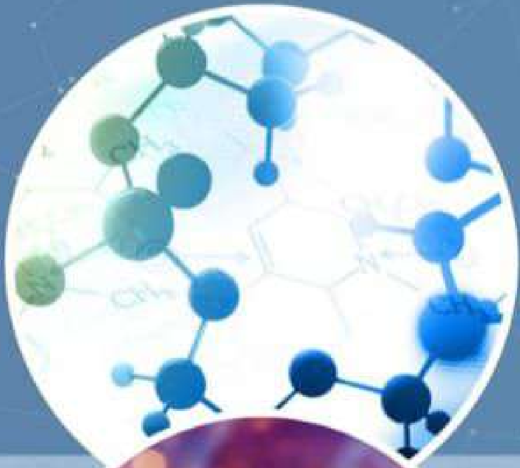

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Chapter 18

BIOMOLECULE: ECOFRIENDLY BIOPLASTIC

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ABSTRACT

What Are Plastics and Where Do They Originate? Plastic was initially defined as "pliable and easily shaped. " It was only lately that it got the term for a class of materials known as polymers. Polymers are comprised of lengthy chains of molecules and have the meaning "of many parts. " Polymers are abundant in nature. Cellulose, the substance that makes up plant cell walls, is a common natural polymer. [20,31]. Almost all synthetic plastics are derived from petroleum and its byproducts. These resources have taken over millions of years to form and are limited in number. Furthermore, plastics manufactured from fossil fuels are typically non-biodegradable. Plastics' growing use has resulted in a rise in plastic garbage, which is frequently disposed as municipal solid waste. As a result, there is an urgent need to produce non-petroleum-based and sustainable feed supplies, which has primarily redirected the focus of many academic and industry researchers towards biobased and biodegradable polymers. Biobased plastics or bioplastics are sustainable, largely biodegradable, and biocompatible, and they reduce our reliance on depleting fossil fuels and are $C0_2$ neutral. However, despite providing a timely and essential need for environmental sustainability, bioplastics have yet to gain a strong position in the plastics world due to less than superior properties of bioplastics compared to their synthetic counterparts. As a result, scientists and engineers worldwide have been investigating ways to enhance the characteristics of bioplastics by blending/compounding them with other polymers and fibres. Green composites, which are made by combining bioplastics and natural fibres, give a sustainable alternative that is completely biodegradable.

KEYWORDS: Bioplastic, Biodegradble Plastic, Material of Bioplastic

INTRODUCTION

NATURE OF PLASTIC

Plastics have progressed from the use of naturally plastic materials (such as gums and shellac) to chemical modification of those materials (such as natural rubber, cellulose, collagen, and milk proteins), and finally to completely synthetic plastics (such as bakelite, epoxy, and PVC). Early plastics were made from organic polymers generated from bio-materials such as egg and blood proteins. Mesoamericans employed natural rubber for balls, bands, and figurines circa 1600 BC. [2]. Bakelite was the world's first entirely synthetic plastic, created in New York in 1907 by Leo Baekeland [1], who popularised the phrase plastics. [9]. Many chemists, including Nobel laureate Hermann Staudinger, have contributed to the materials science of plastics. who has been referred to as "the father of polymer chemistry," and Herman Mark, who has been referred to as "the father of polymer physics. " [9]. What is the difference between polymer and plastic polymer?

DEFINITION OF PLASTIC- Polymers are huge molecules with the same structural unit repeated many times. Plastic is a polymer with a high molecular weight.

NATURE- It might be natural or manufactured. a man-made polymer STRUCTURE – Polymer chains can be either short or long. Polymer chains that are lengthy.

VERSATILITY - The majority of polymers are adaptable. Extremely adaptable Is plastic a kind of polymer? Polymers are all plastics, but not all plastics are polymers. Plastic is a particular sort of polymer. Plastics are man-made and do not exist in nature. [16]. Polymers' repeating units are frequently carbon and hydrogen, but also oxygen, nitrogen, sulphur, chlorine, fluorine, phosphorus, and silicon. [16].

Polymers have very different physical and chemical properties than their monomers. Moreover, according to the number of repeating units in the polymer,

What is Plastic? Plastic is also polymer that has a large molecular mass. The monomers of plastic can be either natural or synthetic. We produce plastic from petrochemicals. Hence, plastic is a synthetic polymer. [16].

Plastics are widely used in a variety of applications, including bottles, bags, boxes, fibres, films, and so on. Plastics can be chemically resistant and thermal and electrical insulators. [26]. The term plasticity here refers to the deformability of the materials used in the production of plastics. Plasticity enables moulding, extrusion, or compression into a wide range of forms, including films, fibres, plates, tubes, bottles, and boxes. Outside the scope of this article, plasticity has a technical term in materials science that refers to the irreversible change in shape of solid substances. Organic polymers are included in the majority of plastics [7].

INTRODUCTION TO BIOPLASTIC

Plastics' extensive usage has become a major cause of worry owing to their harmful influence on the environment, particularly the sources from which plastics are created and their biodegradability. Green composites, which are made by combining bioplastics and natural fibres, give a sustainable alternative that is completely biodegradable. However, studies are being conducted to combine bioplastics with synthetic fillers and/or synthetic plastics with natural fibres. Biocomposites are materials that not only give excellent qualities to fulfil the goal application, but also lessen the carbon footprint on the environment. [12].

The terms 'biobased' and 'biodegradable' are not synonymous. The attribute of biodegradation is tied to a material's chemical structure rather than its resource foundation. In other words, 100% biobased plastics may be non-biodegradable, whereas 100% fossil-based plastics may be biodegradable. [15].

'BIOPLASTIC TYPES'

Bioplastics based on polysaccharides Plastics derived from starch Thermoplastic starch is the most frequently used bioplastic, accounting for over half of the bioplastics market. [33]. Straightforward starch Gelatinizing starch and solution casting can be used to make bioplastic film at home. [24]. Pure starch absorbs humidity and is thus a good substance for the pharmaceutical industry's creation of medication capsules. Pure starch-based bioplastic, on the other hand, is brittle. Plasticizers such as glycerol, glycol, and sorbitol can also be added to allow the starch to be thermo-plastically treated. [21]. By varying the proportions of these additions, the properties of the resultant bioplastic (also known as "thermoplastic starch") may be adjusted to individual applications. Starch may be converted into bioplastic using conventional polymer manufacturing processes. Extrusion, injection moulding, compression moulding, and solution casting are techniques of traditional polymer processing processes that may be utilised to convert starch into bioplastic. [21]. The amylose/amylopectin ratio has a substantial impact on the characteristics of starch bioplastic. High-amylose starch often has greater mechanical characteristics. [22]. High-amylose, on the other hand Biodegradable Plastics vs. Bioplastics When discussing alternative plastics, two words are frequently misconstrued or used interchangeably when they should not be: bioplastics and biodegradable plastics. [13]. What Exactly Are Bioplastics? We call conventional plastic, plastic that is made from fossil fuels and is non-biodegradable. Most of these plastics take centuries to degrade in the environment, and oil-derived plastics leave harmful residues in the soil or water. However, a material might be classified as a bioplastic if it is biobased and biodegradable or biobased but not biodegradable. [14]. Bioplastics are often manufactured from maize starch, cassava starch, or sugarcane. They are a better alternative to petroleum-based plastic since they disintegrate faster and with fewer pollutants. [14]. However, this might be deceiving because just dumping rubbish of any type in a landfill is not a smart idea. Its disintegration, like that of most organic materials, produces methane gas, a greenhouse gas many times more powerful than carbon dioxide. Bioplastics should instead be transported to a professional composting facility where bacteria may break them down in a controlled manner. [13]. The biomass portion of these plant-based plastics produces methane as it decomposes, and they behave in the water like traditional plastics, disintegrating into microplastics and damaging marine life that confuses them for food. [14].

What Is Biodegradable Plastic, Exactly? Biodegradable plastics, on the other hand, are petroleum-based polymers that have been treated with a degradable component. This phrase is frequently used interchangeably with bioplastics, despite the fact that the two are chemically quite distinct. [13].

Because the process of breaking down the material in a compost pile is strongly dependent on humidity and temperature, the word "biodegradable" can potentially mislead customers. Many polymers with this promise will only biodegrade in industrial settings with high enough temperatures. There are numerous different forms of biodegradable plastics, but the most prevalent are polylactic acid (PLA) and polyhydroxyalkanoates (PHA) derived from starch. PLA has the ability to "look and behave like polyethylene (used in plastic films, packing, and bottles), polystyrene (used in plastic foam and plastic cutlery), or polypropylene (used in packaging, auto parts, and textiles)," whereas PHA is produced by microorganisms that produce plastic from carbon-rich organic material and is used in industrial applications such as injection-molded auto parts. [14].

"Biodegradable" because the process of breaking down starch has less process ability due to its greater gelatinization temperature [23]. Plastics derived from cellulose. Cellulose bioplastics are mostly composed of cellulose esters (such as cellulose acetate and nitrocellulose) and their derivatives, such as celluloid. When cellulose is significantly changed, it can become thermoplastic. One example is cellulose acetate, which is costly and so infrequently used in packaging. Due to their lower hydrophilicity than starch, cellulosic fibres added to starches can increase mechanical characteristics, gas permeability, and water resistance [4]. A team from Shanghai University used a technique known as hot pressing to create a new green plastic based on cellulose [29].

Protein-based plastics Bioplastics can be made from a variety of proteins. For example, wheat gluten, milk, and casein show promising properties as a raw material for various biodegradable polymers [30]. Additionally, soy protein is being considered as another source of bioplastic. Soy proteins have been used in plastic production for over a century, and the body panels of an original Ford automobile were made of soy-based plastic [27]. Because of their water sensitivity and relatively high cost, soy protein-based polymers pose challenges. As a result, combining soy protein with certain commercially available biodegradable polyesters enhances water sensitivity and cost. [36]. Polyesters with aliphatic chains PHB (poly-3-hydroxybutyrate), PHA (polyhydroxyalkanoates), PHV (polyhydroxyvalerate), polyhydroxyhexanoate PHH, PLA (polylactic acid), and polyamide 11 (PA11) are examples of biobased polyesters. They are all susceptible to hydrolytic breakdown to varying degrees and can be combined with other chemicals. [17]. Polyethylene (Organic) Polyethylene derived from the fermentation of basic agricultural ingredients such as sugar cane and maize, rather than from fossil fuels. [17].

BENEFITS OF BIOPLASTICS

Bioplastics are pushing plastics evolution. Biobased plastic products have two key benefits over traditional plastics: they conserve fossil resources by employing biomass that regenerates (annually) and have the unique possibility for carbon neutrality. Furthermore, biodegradability is a feature of several forms of bioplastics. It provides extra recovery options at the conclusion of a product's life cycle. [15]. Where Are Bioplastics Used Right Now? Bioplastics may appear to be a new age idea, yet they have been around for at least a century. The Ford Model T, for example, was built with maize and soybean oil components. As the difficulties associated with petroleum-based plastics have become more evident, bioplastics are increasingly being utilised to manufacture food containers, supermarket bags, disposable cutlery, packaging, and other items. PLA, in example, has been employed in a variety of applications such as plastic films, bottles, medical equipment, and shrink wrap. It has also been utilised in 3D printing for specialised purposes. Bioplastics have been used in the packaging materials of several major corporations, including Coca-Cola, PepsiCo, Heinz, Ford, Mercedes-Benz, and Toyota. [17].

ENVIRONMENTAL IMPACT OF BIOPLASTIC

Materials such as starch, cellulose, wood, sugar, and biomass are utilised to generate bioplastics in place of fossil fuel resources, making bioplastic manufacturing a more sustainable activity than traditional plastic production [11]. The environmental effect of bioplastics is frequently discussed, as there are several criteria for "greenness" (for example, water usage, energy use, deforestation, biodegradation, and so on) [35,3,25]. As a result, the environmental implications of bioplastics are classified as nonrenewable energy usage, climate change, eutrophication, and acidification [34]. Bioplastic manufacture cuts greenhouse gas emissions and nonrenewable energy use dramatically [11]. Bioplastics would also allow businesses all over the world to improve the environmental sustainability of their goods. [5]. Although bioplastics utilise less nonrenewable energy than traditional plastics and release less greenhouse gases, they can have severe environmental effects such as eutrophication and acidification [34]. Bioplastics have a larger potential for eutrophication than ordinary plastics. Biomass generation during industrial agricultural practises causes nitrate and phosphate to filter into water bodies, resulting in eutrophication, the process by which a body of water becomes too nutrient-rich. [34]. Eutrophication is a global danger to water resources because it creates destructive algal blooms, which create oxygen dead zones and kill aquatic organisms. [28]. Although bioplastics utilise less nonrenewable energy than traditional plastics and release less greenhouse gases, they can have severe environmental effects such as eutrophication and acidification [34]. Bioplastics have a larger potential for eutrophication than ordinary plastics. Biomass generation during industrial agricultural practises causes nitrate and phosphate to filter into water bodies, resulting in eutrophication, the process by which a body of water becomes too nutrient-rich. [34]. Eutrophication is a global danger to water resources because it creates destructive algal blooms, which create oxygen dead zones and kill aquatic organisms. [28]. Certain types of bioplastics as well as conventional plastics containing additives are able to biodegrade. [10]. Bioplastics may biodegrade in a variety of situations, making them more acceptable than traditional plastics. Bioplastics biodegrade in a variety of habitats, including soil, aquatic environments, and compost. Because the structure and content of a biopolymer or bio-composite influence the biodegradation process, altering the composition and structure may improve biodegradability. Because of their great microbial variety, soil and compost as environmental conditions are more effective in biodegradation composting not only biodegrades bioplastics effectively, but it also considerably decreases greenhouse gas emissions. Bioplastics' biodegradability in compost settings can be improved by adding more soluble sugar and raising the temperature. faster than the infrastructure we need for their safe, circular disposal and multinational Soil environments, on the other hand, include a wide variety of microorganisms, making biodegradation of bioplastics easier. However, bioplastics in soil settings require greater temperatures and a longer biodegradation period. Some bioplastics biodegrade more quickly in bodies of water and marine systems; nonetheless, this poses a risk to marine ecosystems and freshwater. [8]. As a result, it is reasonable to assume that biodegradation of bioplastics in water bodies, which results in the death of aquatic species and polluted water, is one of the negative environmental effects of bioplastics. For the time being, consider bioplastics to be plastic. For the Time Being, Think of Bioplastics as Plastic The reality is that we are producing bioplastics faster than the infrastructure required for their safe, circular disposal, and multinational brands must lead the way on clear, transparent labelling to educate consumers. Until we establish an end-of-life solution for bioplastics, they will end up in landfills or polluting waterways in the same way that conventional plastic does. For the Time Being, Think of Bioplastics as Plastic The reality is that we are producing bioplastics faster than the infrastructure required for their safe, circular disposal, and multinational brands must lead the way on clear, transparent labelling to educate consumers. Until we establish an end-of-life solution for bioplastics, they will end up in landfills or polluting waterways in the same way that conventional plastic does. [19].

CONCLUSION

The bioplastic making by using Agar –agar powder, Gelatin powder and Starch with Glycerol/Glycerine as plasticizer. Different combinations and proportion of ingredients used to form different types of bioplastics. To check their different properties, Physical properties like Tensile strength, Elongation, Thickness, Water absorption capacity of bioplastic were determined using newton meter, Screw gauge, etc. Bioplastic can be characterized by FTIR technique and then bioplastic spectra compared with conventional plastic (HDPE) spectra. Biodegradation test (Natural Degradation) may be conducted with the interval of every 6 days for 21 days to ensured how much percentage of bioplastic degrade in soil in particular time period. Carbon footprint become lesser by use of bioplastic

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