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A Review on Biodegradable Plastics and Its Future

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ABSTRACT: Synthetic polymers play a significant role in a variety of industries, especially packaging. However, it has a negative impact on the environment and creates issues with trash disposal and consumption. As a result, there's a trend toward replacing the polymer with a biodegradable polymer that goes through a procedure. This study includes information on consumption, biodegradation, commercialization dependability, and renewable energy generation. Microorganisms may break down biodegradable and compostable materials into water, carbon dioxide, mineral salts, and new biomass in a certain amount of time. The circumstances under which a biodegradable or compostable plastic item dissolves and how fast it degrades are very dependent on the environment under which it is discarded. Commercialized biodegradable polymers includes starch based plastic, bacteria's based plastic, cellulose-based plastics, soy-based plastics, lignin-based plastics, & naturally made fibers reinforced plastic. The manufacture of the kind of the materials & it introductions to markets are crucial for environment.

KEYWORDS: Biodegradable Polymer - Starch Based Plastic - Bacteria Based Plastic - Soy Based Plastic - Cellulose Based Plastic - Lignin Based Plastic - Natural Fiber Reinforced Plastic.

I. INTRODUCTION

Due to the growing amount of trash and the ineffectiveness of the mechanisms in place to deal with the issue holistically, Malaysia's municipal solid waste (MSW) has become a concern.

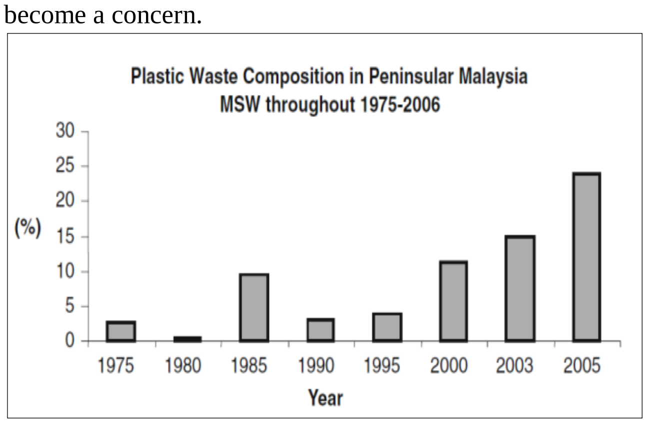

Figure 1: Illustrates the plastic waste composition in peninsular Malaysia.

The typical composition of MSW in Malaysia is estimated to be 45 percent food waste, 24 percent plastics, 7% paper materials, 6% iron, 4% wood, and 3% glass, with the rest components unclassified. In Malaysia, plastic trash combined with solid garbage is made comprised of plastic components that are difficult to degrade. Plastic content has risen from 015.00001 percent in 2006 to 024.00001 percent in 2007, implying that are about 04550.0001 ton of the plastics trash every 019000.0001 ton of the produced shown in figure 1 [1].

Polyethylene, which is extensively utilized in different packaging applications, is a significant contributors to the waste plastic. Poly bag used for the spreading the seed & mulches film used conceal limitations planting seedling are among the numerous wasted plastic products in the agriculture industry. Low densities polyethylene (LDPE), linearly low densities polyethylene's (LLDPE), and very high density polyethylene's (HDPE) are most frequently used poly bags and mulch films. The puncture resistance and mechanical tensile characteristics of LDPE resin are excellent. HDPE resins provide a moisture and steam barrier. The perfect plastic mulch film is flexible, stiff, and adaptable to a variety of conditions. The most common polyethylene used in mulch films is LDPE [2].

Though recycling process is an effective way of reducing plastic wastage, it is fraught with complications. The cost of recycling can be more than the cost of making new plastic. Plastic made from petroleum is not biodegradable and may endure for hundreds of years. Microorganisms, UV light, heat, and water have little effect on plastic. Plastic not only causes difficulties with disposal, but it also has an impact on marine life. Most frequently and wide technique dispose of municipal solid wastage is landfilling. Many synthetics polymer that is resistant to the chemical and physical degradations are now discarded alongside regular trash. Biodegradation is an alternate way of disposal for agricultural plastic waste. Concerns about disposal and biodegradation have led to the creation of biodegradable polymers, which are degradation copyright resistance plastics.

II. BIODEGRADABLE PLASTICS

In the recent year, biodegradable plastic have been the extensively researched & commercialized in the production of a variety of goods, including trash bag, poly bags, compost bags, and agriculture mulch film. After being disposed of in the environment, biodegradable plastics may be degraded by microorganisms, resulting in the end product CO_2 & H_2O. Preliminary research in area of a new technology have indicated that uses of biodegradable plastic by farmers may decrease the quantity and expense of waste disposal. Researchers have explored photodegradable polymers, mulch film, and biodegradable plastics as alternatives to petroleum-based plastics. Use of biodegradables mulches film or the photodegradable polymers may help satisfy the increasing demand for alternatives to petroleum-based goods while also lowering the labor cost of manufacturing mulch film after it has been used [3], [4].

Polylactics acid (PLA) and polyhydroxyalkanoate (PHA) are two kinds of biodegradable polymers that have a part in ecologically friendly mulch film. PLA's is biodegradable polyesters that is very much flexible & made entirely from the renewable resource like maize & starches. It has a lot of potential in a variety of commodity applications. Microorganisms convert starch to lactic during the fermentations. The lactic acid molecule were joined together to form polymers, which are lengthy chains of lactic acid molecules. PLA is biopolymers that is relative cheap to the manufacture & can manufactured huge numbers. Because it is highly appealing for biological and medical applications. The potential PHA biodegradable polymers have been recognized as green. Bacteria and plants can both generate PHA polymers, although microbes are the most common source at the moment. PHA's high manufacturing costs have been a significant deterrent to its use as a substitute for petrochemical plastics. PHA cannot compete with the bulk manufacturing of petrochemical plastics at present moment since commodity prices of plastics derived from petroleum, such as PE and polypropylene (PP), are below USD 1 / kg. Efforts have been made to decrease the cost of manufacturing by developing efficient bacteria, strains, fermentation, and recovery methods. Ecologically benign & biodegradable natures, PHA development has garnered a lot of interest as a possible replacement for traditional plastic. PHA has a wide range of potential uses in a variety of sectors, and its use in medicine is particularly promising [5]–[8].

Photodegradable and biodegradable polymers are the two kinds of degradable plastics. Photodegradable plastics is typically composed of the plastic polymers and, like traditional plastic, is oil-based. It has a structure that allows sunlight to weaken and destroy the link, or it has the chemic additive that absorbs the light & attack the polymers, breaking some of bond. Rather of completely decomposing, photo-degradable plastics tend to the break down into the tiny plastic particles. Unfortunately, with the non-biodegradable plastic that stay in environment, this is not always the case. The majority of plastic trash now end up in a landfill, where it buried in earth. Photodegradable plastic will not breakdown under these circumstances [9]–[11].

Oils or plant-based products may be used to make biodegradable plastics. Biodegradables plastics will vulnerable to the bacteria, fungus, and microorganisms can utilize them as food throughout the breakdown process. Biodegradability testing has been performed on biodegradable polymers to verify that they can degrade. PE may be biodegradable if the chains are smaller than 500 molecular weight, whereas most of the other polymer molecular weight not. Although polyesters is biodegradable, it was formerly widely utilized in packaging materials. Polyester will not assist address the waste disposal issue since the bulk of plastic waste comes from packaging.

There are a growing number of commercial biodegradable plastics producers on the market today. The following are some examples of biodegradable polymers on the market:

1. Plastics made of starch,
2. Bacteria-based plastics,
3. Plastics made from soy,
4. Plastics made of cellulose,
5. Plastics made of lignin and
6. Plastic reinforced with natural fibers.

A. Plastics Made of Starch

Wheat, potatoes, rice, and maize are the most common sources of starch-based polymers. Corn is the cheapest and most widely utilized of all four starches, whereas starch is the most costly. Items have been made using starch-based polymers. Traditional methods such as the injections moldings, blows moldings, extrusion, blown film, & thermos forming may be used to process starch biodegradable plastics. The polymers chains known as the polylacitide (PLA) or the polygloycolic, the process converts starch into lactic acid monomers (PGA). PLA is a crystalline polymer like PGA, however the PLA more than hydrophobic than the PGA. The PLA is the brittles & stiffs, therefore most uses need plasticizers. PLA plastic is also known for its high gloss and clarity. PLA is unique in that it is derived from renewable sources such as starches.

B. Bacteria-Based Plastics

Bacteria are employed as an extra treatment in the production of biodegradable polymers. In bacterial cells, polymer chain polyhydroxyalkanoate (PHA) is formed. After being cultivated in culture, bacteria are collected and turned into biodegradable polymers. Depending on the requirements of the product, the resin's mechanical characteristics may be altered.

More than 30% of bacteria found in soil may produce PHA. The bacteria have also been discovered in activated sludge, the sea, and other harsh settings. PHA has quickly evolved in the last ten years, finding applications in a wide range of areas. PHA has a lot of cool features that are based on the structure. Depending on the bacterium species and growing circumstances, homopolymer, block copolymers, and random copolymers of PHA may generated. PHA with thermal & mechanical flexibility has been created, with the over 0150.0001 distinct PHAs monomer described. The PHA monomers may also be utilized to produce biofuels, and their diversities has the enabled for developments of range uses, ecologically friendlies biodegradables plastic for the packaging, textiles, & biodegradable implant.

C. Plastics Made of Soy

Soy-based plastics are a kind of biodegradable plastic that uses a different type of substance. Soybeans are high in protein and low in fats and oils. Protein content in soy beans ranges from 40 to 55 percent. Soy may be molded into plastic products and films due to its high protein content. The films generated are typically used for food coating, however they have recently been utilized to make a soy protein plastic container. Ford has made use of soy protein polymers in the manufacture of automobile components. Compression and injection molding may both be done using soy protein polymers.

D. Plastics Made of Cellulose

Plant cellulose is often used to make modified cellulose-based plastics. Wood pulp, hemp, and cotton are examples of frequently utilized cellulose sources. Cellulose is the most common biopolymer on the planet, found in a wide range of animals, plants, and microorganisms.

E. Plastics Made of Lignin

Lignin-based plastic (also known as the lignocellulosic plants materials) a waste product the papers industries. Oil phenolic, adhesives, and epoxy resins may all be replaced by lignin. The incorporation of lignin into the matrix polymer (polyolefin) has many advantages, including improved chemistry, UV stability, and biodegradation capabilities. Possesses properties that can be used to make biodegradable products. The following are some of the advantages of lignin as a component in the polymer matrix:
Lower the price of composite materials;
Because of the interaction between the different functional groups of lignin and the polymer matrix, it has good compatibility with natural or synthesized polymers. In biodegradable green mixes, an environmentally beneficial filler. Polycaprolactone (PCL) and poly (l-lactic acid) are now used as reinforcing fillers in aliphatic polyester (PLLA). In a separate research, lignosulphonate calcium (LS) was used to successfully add lignin to PBS as a filler. The resulting combination demonstrated that high modulus may be reduced while expenses are reduced.

F. Natural Fiber Reinforced Plastics

Because of their cheap cost, acceptable specific strength, modulus, and biodegradability the resulting combination demonstrated that high modulus may be reduced while expenses are reduced.is beneficial to the environment since it reduces the amount of trash wasted. Natural fibers provide several advantages, including cheap cost, biodegradability, high strength and modulus, low density, ease of processing, and reactive surfaces for certain uses.
Polycaprolactone (PCL) and poly (l-lactic acid) are now used as reinforcing fillers in aliphatic polyester (PLLA) are the two main types of natural fibers (Figure 2). Polycaprolactone (PCL) and poly (l-lactic acid) are now used as reinforcing fillers in aliphatic polyester (PLLA) creation of PP bio-composite in the automobile sector. Biopolymers as a replacement for PP biocomposite will be more ecologically friendly and meet eco-friendly bio composite for twenty-first century green car components applications. Another kind of grass fiber is bio fiber, which is gaining popularity among researchers as a reinforcing fiber for automotive applications.

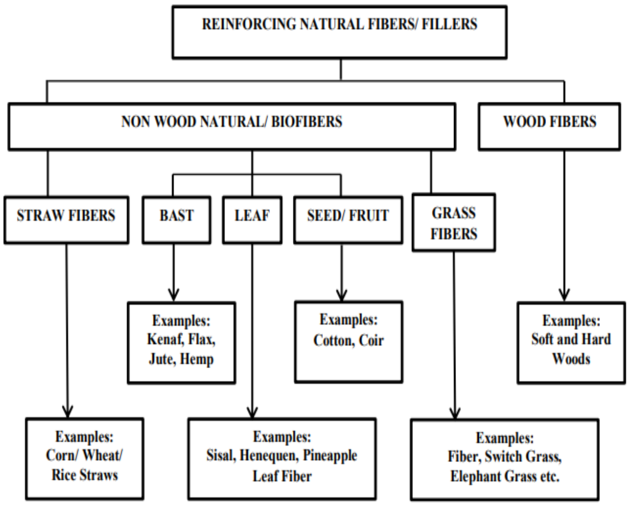

Figure 2: Illustrates the classification of natural/bio fibers.

III. DISCUSSION

Bioplastics have received a lot of attention in recent years due to their environmental benefits. Biobased polymers may seem to be a recent invention, yet some have been used since the dawn of humanity. For example, the latex ball used by Mayan pelote players. Man has relied on biomass to fulfill his needs and develop throughout history. The term "biomass" refers to all forms of biological stuff, including plants and animals. A total of 172 billion tons of organic matter are generated each year, of which only 3.5 percent is used, mostly for food. As the industrial age began, scientists turned to biomass for the first artificial polymers, such as celluloid, the first plastic made in 1856 from cellulose nitrate and camphor, or gala lithe, a biodegradable polymer made from formalin and casein, a milk protein. Henry Ford was able to manufacture plastic vehicle components generated from soybeans because to the efforts of pioneers in chemurgical (the chemical and industrial utilization of organic raw materials). When petroleum became a source of fuel and chemicals in the early 1900s, the history of plastics altered significantly. Plastics produced from synthetic polymers simply replaced early bioplastics, such as polylactic acid (PLA), which was discovered about 1890. Plastics manufacturing grew dramatically during World War II, and it continues to expand now. Cellophane, a cellulose-based sheet material, is one well-established bioplastic that has outlasted the synthetic plastics industry's development. Despite the fact that manufacturing peaked in the 1960s, it is still used in candy, cigarette, and other product packaging. To produce the almost 300 million tons of plastics used each year, just approximately 4% of the world's fossil resources are used. However, assuming current plastics use development continues at its present rate, the plastics industry would account for 20% of global oil consumption by 2050. (World Economic Forum, 2016). Growing scarcity and rising raw material costs have pushed the production of plastics made from renewable resources back into the spotlight.

IV. CONCLUSION

Researchers are looking for novel materials that can be recycled naturally due to technical and economic issues with recycling materials. Synthetic polymers have a detrimental effect on the natural environment, which causes a slew of issues with trash disposal and consumption. Although biodegradable polymers have been investigated, renewable polymer-based sources are the most desired. The primary benefit of biodegradable polymers is that they may be composted with organic waste and returned to the soil to improve it. Because they are parsed by nature, their usage will not only minimize the dangers to animals posed by dumping traditional plastic, but it will also lower the cost of labor for removing plastic trash from the environment. By limiting the amount of trash that can be recycled into usable monomers and oligomers via microbial and enzyme treatments, decomposition will help landfills last longer and be more stable. Using biodegradable polymers instead of synthetic materials in a number of sectors may assist to preserve the environment substantially.

REFERENCES

[1] A. Periathamby, F. S. Hamid, and K. Khidzir, "Evolution of solid waste management in Malaysia: Impacts and implications of the solid waste bill, 2007," J. Mater. Cycles Waste Manag., 2009, doi: 10.1007/s10163-008-0231-3.

[2] A. M. Al-Sabagh, F. Z. Yehia, G. Eshaq, A. M. Rabie, and A. E. ElMetwally, "Greener routes for recycling of polyethylene terephthalate," Egyptian Journal of Petroleum. 2016, doi: 10.1016/j.ejpe.2015.03.001.

[3] M. Rujnić-Sokele and A. Pilipović, "Challenges and opportunities of biodegradable plastics: A mini review," Waste Management and Research. 2017, doi: 10.1177/0734242X16683272.

[4] C. Dussud et al., "Colonization of non-biodegradable and biodegradable plastics by marine microorganisms," Front. Microbiol., 2018, doi: 10.3389/fmicb.2018.01571.

[5] P. Jambunathan and K. Zhang, "Engineered biosynthesis of biodegradable polymers," Journal of Industrial Microbiology and Biotechnology. 2016, doi: 10.1007/s10295-016-1785-z.

[6] M. Hirschenauer and M. Washüttl, "Biokunststoffe," Ernahrung, 2013, doi: 10.1365/s35725-011-0036-5.

[7] T. A. Hottle, M. M. Bilec, and A. E. Landis, "Sustainability assessments of bio-based polymers," Polymer Degradation and Stability. 2013, doi: 10.1016/j.polymdegradstab.2013.06.016.

[8] D. G. Hayes et al., "Effect of diverse weathering conditions on the physicochemical properties of biodegradable plastic mulches," Polym. Test., 2017, doi: 10.1016/j.polymertesting.2017.07.027.

[9] S. Kasirajan and M. Ngouajio, "Polyethylene and biodegradable mulches for agricultural applications: A review," Agronomy for Sustainable Development. 2012, doi: 10.1007/s13593-011-0068-3.

[10] N. Yang et al., "Plastic film mulching for water-efficient agricultural applications and degradable films materials development research," Materials and Manufacturing Processes. 2015, doi: 10.1080/10426914.2014.930958.

[11] K. J. Arrington, J. B. Waugh, S. C. Radzinski, and J. B. Matson, "Photo- and Biodegradable Thermoplastic Elastomers: Combining Ketone-Containing Polybutadiene with Polylactide Using Ring-Opening Polymerization and Ring-Opening Metathesis Polymerization," Macromolecules, 2017, doi: 10.1021/acs.macromol.7b00479.