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Production of Biodegradable Plastic from Food Waste

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Abstract: Synthetic plastics are widely used, mostly in packaging industries and also in forms of disposable utensils. But, this also influences in increasing waste and polluting the environment rapidly. To deal with this, the use of biodegradable plastic is growing a lot faster than before. This work summarizes the role of food waste and their starch in producing biodegradable plastics and witnessed the making of biodegradable plastic from different types of food waste. This material will majorly help in reducing food waste and also in controlling plastic waste. Also, this paper covers the basic details on the cost for commercialization required for making this material available for use publicly. Some biodegradable plastics which are already available for commercialization are starch based, lignin based, bacteria based, cellulose based and fibre reinforced plastics. Our review is based on the starch based bioplastic from potato peels, cellulose based from banana peels, lignin based from pumpkin waste.

Keywords: Biocomposites; Biodegradable plastics; Biopolymer; Food waste based plastic; Plasticized starch.

I. INTRODUCTION

Synthetic polymers mainly plastics are important in many industries like packaging industry, in transportation, in building and constructions. However, the widely use of this has led to the undesirable influence on the environment in causing high level pollution which gives rise to the problems related to the degradation of consumed waste which in the end results in the increase in the waste plastics.

On an average the world is facing a major threat in the form of uncontrolled increased in production of municipal waste management due to population growth, industrialization and economic development. Overall, there are few cities where municipality corporations have specific teams and various public policies which are solely working in managing waste in their particular areas and are engaged in dealing all the problems regarding waste management [S.P. Gautam,2009]. Also these teams work on developing solutions for waste decomposition to prevent contamination of soil, water and water bodies, and also from various types of illness like diarrhoea, amebiasis which happens when waste are not decomposed.

Various solutions are developed like landfills in appropriate places, adoption of selective collection and recycling programs, conduction of campaign with the sole objective of making society aware about the problems of waste management and demanding their participation and as well as of official government authorities. Among these solutions the manufacture of biodegradable materials offers an interesting solution for the decomposition of plastic material.

Bioplastic are those materials which can from the basis for the environmental preferable and a best alternative to the current materials which are only petroleum based feed stocks.

Classes of Biodegradable Materials-

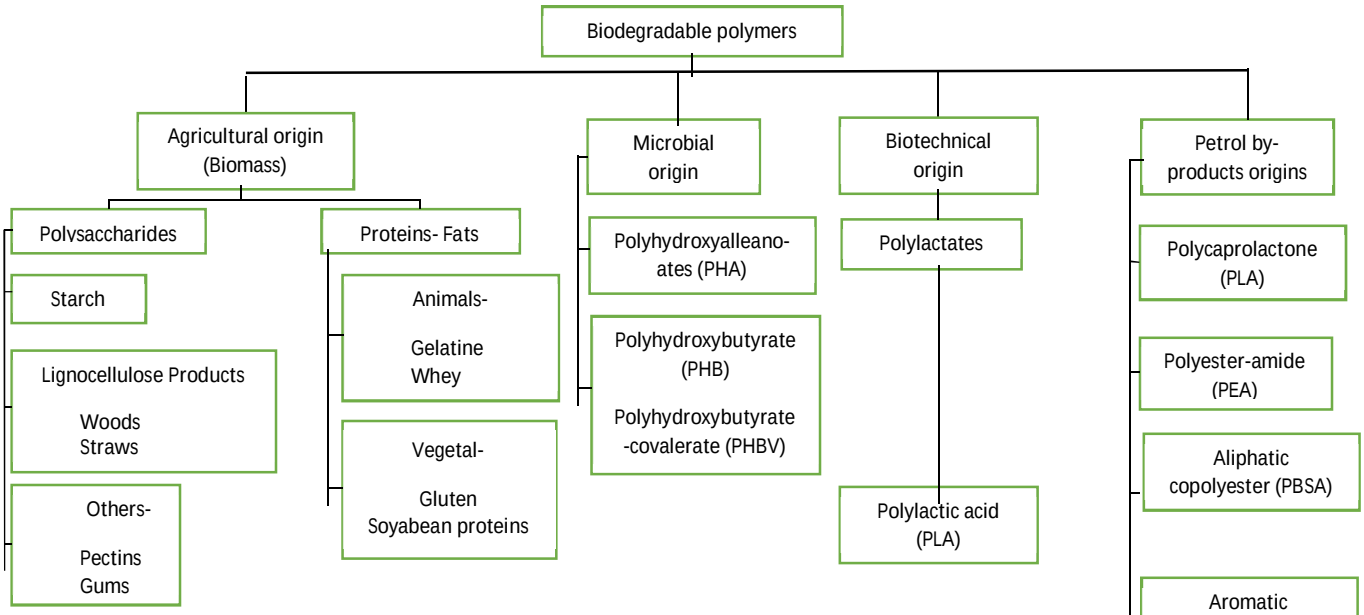
Three classes of biodegradable materials [Guilbert 2000] -

1) Agricultural polymers produced from food, fats and proteins.
2) Microbial polymers produced from the fermentation of agricultural products. Widely known material is Polyhydroxybutyratecocalrate (PHBV).
3) Monomers are biotechnical origins and are produced by chemical process. Widely known material is PLA.

Fourth class of biodegradable materials [Averous 2002] –

4) Derivatives from synthetic materials from petrochemical industry. Furthermore, this class of biodegradable materials are classified in the following subgroups:
a) The polycaprolactones (PCL).
b) The polyesteramides (PEA).
c) The aliphatic copolysters.
d) The aromatic copolysters.

Other than the starch derived polymers only PLA and PCL are the two which are widely used in the market (Averous 2002). Figure 1 gives the brief knowledge about the different families of biopolymers and their raw materials used.



Source: Adapted from Guilbert (2000) and Weber (2000)

II. BIODEGRADABLE PLASTICS FROM FOOD WASTE

If food waste is left in the environment for rotting in an open landfill it creates many problems. According to United Nations Environment Program (UNEP) the estimated carbon footprints due to the waste food is 3.3 billion tons of carbon equivalent [Gina-Marie 2014]. In other words, we can also relate wasted food with wasted water because of the requirement of water for producing food. And when food is wasted so is water. The amount of water wasted due to waste food annually is approximately equal to the annual flow of Volga river in Russia, which becomes extremely poignant in case of dire drought. So to overcome this dual type of waste some steps like making biodegradable plastics or bioplastics from food waste by using starch which is presented in the wasted food or by using main components of plants like edible food waste (parts of the vegetables which normally people don't like to eat) which are cellulose, hemicellulose and lignin [Ilker S. Bayer et.al. 2014].

Also, some other types of biodegradable plastics are made by using bacteria present in environment and/or reinforcing plastics with fibre to grant them the ability to get decompose naturally.

A. Starch Based

Starch is a white granular like organic material which is found in all green plants. For the production of biodegradable plastics starch is basically collected from potatoes, wheat, rice or rice hulls and maize. It is insoluble in cold water and alcohols [Liu, H. et.al. 2009]. It is a polysaccharide compound comprising of glucose as a monomer in α1,4 linkages. Starch consist of two types of component mainly: Amylose and Amylopectin. Amylose provides strength to the film and also a branched structure which gives more space between the molecules. Whereas, amylopectin provides low mechanical properties to the film [Liu, H. et.al. 2009].

Also these biodegradable plastic made from the starch takes less time as compared to traditional plastics which are based on the petroleum byproducts. To increase the flexibility of the plastic film plasticizers are added to the starch while doing the process, which have the ability to create less internal hydrogen bonding in the polymer while increasing their molecular space, thus granting more flexibility to the film. Commonly used plasticizers are sorbitol and glycerol which are also known as the polyols [M. Rico et.al 2016].

B. Cellulose and Hemicellulose Based

Biodegradable plastics which are obtained from industrially used edible vegetable and cereal wastes have high range of mechanical properties. Trifluoroacetic acid (TFA) is used for synthesizing various food related waste like rice hulls, cocoa husks and spinach stems. The bioplastics which are made from this type of synthesizing process are called cellulose based biodegradable plastic or bioplastic [Ilker S. Bayer et.al 2014]. On mixing spinach stems in TFA a layer or film like plastic is formed in less time as compared

to rice hulls and cocoa husks in TFA in which cellulose and hemicellulose are present in rather large quantity the TFA itself [Le Reverand et.al. 2009]. This food related wastes have high compatibility with cellulose, hence hemicellulose can be mixed with this while processing which will plasticize them naturally and will increase their mechanical properties by several folds and bring it on the equal terms with nondegrading petroleum based synthetic polymer materials in terms of mechanical properties. Also, it will provide high opportunities to us so that we will be easily able to replace nondegrading polymer materials with this cellulose based materials having high biodegradability [Ilker S. Bayer et.al 2014].

C. Lignin Based

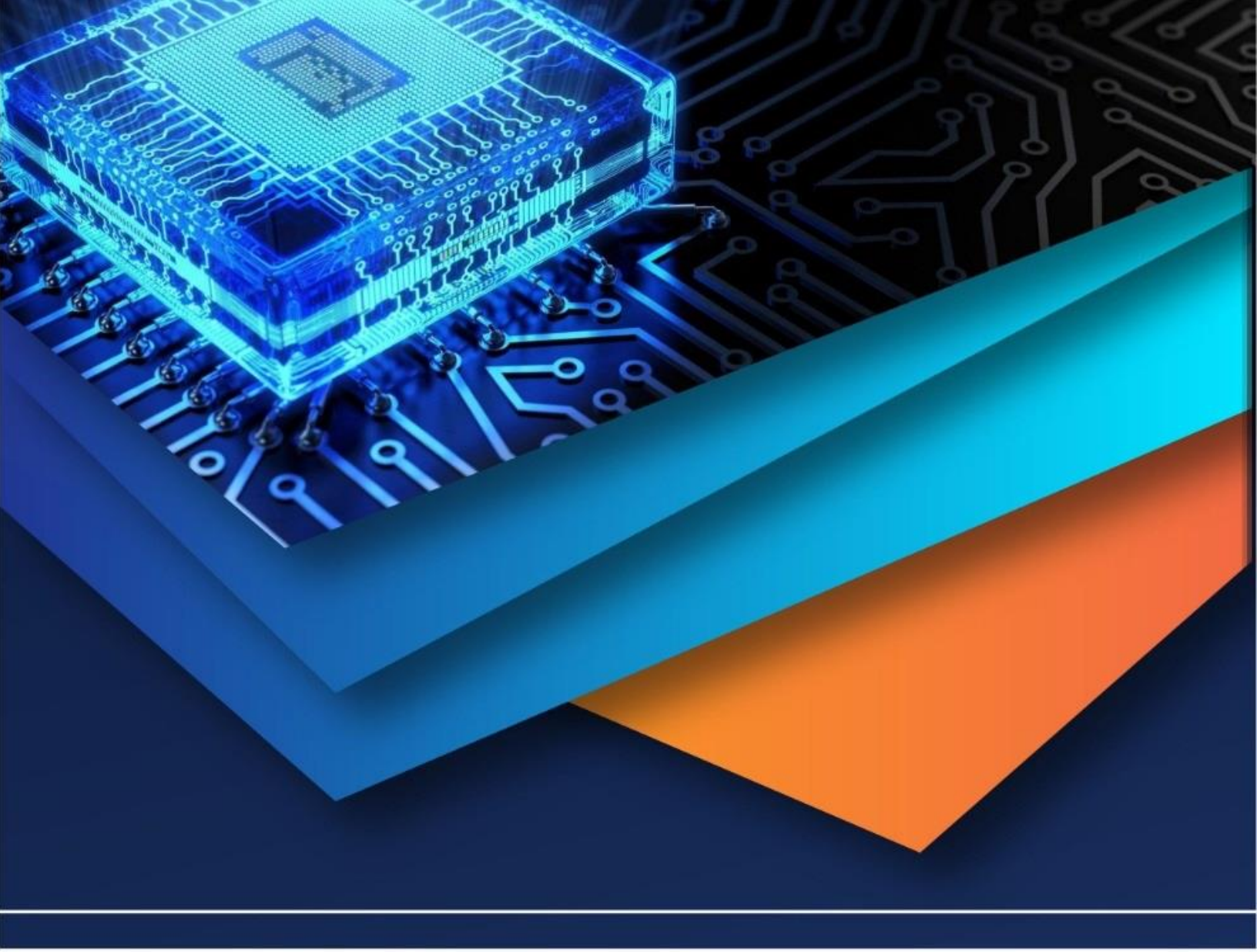
Lignin is complex polymer of aromatic alcohols known as monolignols. Lignin can be biodegrade easily with the help of any one kind of fungi like white rot, brown rot and soft rot which can lead to the destruction of woods or any manmade wooden structures. Lignin based biodegradable materials can be made by mixing Trifluoroacetic acid (TFA) with parsley stem and cocoa husks. The bioplastics synthesized by this process is called lignin based biodegradable plastics or bioplastics [Ilker S. Bayer et.al 2014]. Biodegradation of lignin based bioplastics happens due to the attack of the fungi on lignin present in the polymer material. This degradation process is a time consuming process as compared to the cellulose based bioplastics either way it is a far better bioplastic than the nondegrading polymer materials.

III. CONCLUSION

In this work we demonstrated how biodegradable plastic can be made from wasted food from different process which can be classified differently on the basis of their primary component present in it. Also these components have main role in the biological degradation of these bioplastics in the environment naturally. These types of bioplastics have equivalent strength to that of petroleum based plastics or traditional plastics. Also these polymer materials have high durability, less fragile, less brittle and most importantly more life as compared to the petroleum byproducts based plastics.

REFERENCE

[1] Averous, L. Etude de systemes polymeres multiphases: approche des relations materiaux-procedes-proprietes. Hablitation a diriger des recherches. Universite de Reims Champagne- Adrenne. 2002
[2] Gina-Marie Cheeseman, Food waste turned into bioplastics. Triple Pundite.2014
[3] Guilbert, S. Potential of the protein based biomaterials for food industry. THE FOOD BIOPACK CONFERNCE. 2000
[4] Ilker S. Bayer, Susana Guzman-Puyol, José Alejandro Heredia-Guerrero, Luca Ceseracciu, Francesca Pignatelli, Roberta Ruffilli, Roberto Cingolani, and Athanassia Athanassiou. Direct Transformation of Edible Vegetable Waste into Bioplastics. Americans Chemical Society's Macromolecules. 2014
[5] Le Reverend, B. J. D.; Fryer, P. J.; Bakalis, S. Modelling crystallization and melting kinetics of cocoa butter in chocolate and application to confectionery manufacturing. Soft Matter 5, 891− 902. 2009
[6] Liu, H., Xie, F., Yu, I., Chen, L., Li, L. Thermal processing of starch based polymers. Progress in polymer science, 34, 1348-1368. 2009
[7] M. Rico, S. Rodriguez-Llamazeres, L. Barral, R. Bouza, B. Montero. Processing and characterisation of polyols plasticized starch reinforced with microcrystalline cellulose. Elsevier limited. 2016
[8] N.A Faris, N.Z. Noriman and Sam.S.T ; Current Research in Biodegradable Plastics. Applied mechanics and material. 2014
[9] Oliver Vilpoux, Luc Averous. Book-3, Technology, use and potential of Latin American starchy tubers 2005
[10] Professor S.P. Gautam. "Bio-degradable Plastics- Impact on Environment". Central Pollution Control Board, Ministry of Environment & Forest, Government of India. 2009
[11] Weber, C.J. Foodstuffs packaging biopolymers. Biobased packaging materials for the food industry. Status and Perspective. The European Concerted Action 2000



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