Development of Biodegradable Plastics From Potato Starch With Enhanced Physico-Mechanical Properties Comparative to the Regular Plastic

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Background Literature: The ingenuity behind inventing plastic was considered as a groundbreaking innovation when it first came into widespread use in general goods and jewelry in the 1920s (Bud & Friedel, 1984). The diversity and adaptability of plastic have made it as a day to day life product in almost all over the globe (Gibb, 2019). Plastic is very much indestructible even after a long period of time in the environment (Verma et al., 2016). Due to the low production cost and easy manufacturing process of plastic materials, it is very much impossible to create an absolute alternative of plastic materials. The main building block of plastic polymers is the Hydro-Carbon monomers. C-C bond and C-H bond are very much strong in nature which makes the polymers resistive to the environmental facts (Turner, 2018). Plastics have various uses starting from the product packing to the medical uses and so on. However the non-biodegradability property of these plastic materials is creating a great environmental threat for all the living beings of this planet. Most of the manufactured plastics are getting dumped into the sea which is then consumed by sea creatures and thus entering into our food chain (Pahl et al., 2017). This uprising problem drives the innovators to find the green alternative of plastic materials where starch based products remain as front liner. Starch is one kind of natural biopolymer which has mainly two polymer types of glucose namely amylose and amylopectin. Like the plastic materials, starch also consisted of long chain polymers as well (Lu et al., 2019). The main advantages of starch-based biodegradable plastic are its abundance of raw materials and easy manufacturing process with low cost. However, most of the starch based plastics show very poor physical properties such as low tensile strength, stiffness and elongation at break as well as poor moisture stability, which are not suitable for being used as the replacement of plastic products (Dogossy & Czigany, 2011). It is important to enhance the physical and mechanical properties of starch based plastic in order to use them as an alternative of plastics.

Purpose and Significance: In this project work the main focus is to develop the manufacturing process of starch based biodegradable plastic with optimal physical and mechanical properties. Improvement of the properties of the starch-based bio-composites is being attempted through starch modification, reinforcements (both organic and inorganic), processing conditions and use of compatibilizers to develop substitutes for the conventional plastics.

Materials and Methods: As the sustainable source of starch which is the main raw material to produce biodegradable plastic, potato is the perfect competitor due to its huge cultivation all over the world. The starch extracting process from the potato is a very conventional and easy process. Starch itself can create a film like martial which exhibits very poor mechanical properties. To overcome that hurdle in this project different organic and inorganic chemicals and auxiliaries are added with starch to enhance the physical and mechanical properties. Starch modification has been done by blending starch with polyvinyl alcohol or PVA (polymerizing material) which helps the starch to build much stronger long chain polymer bond (Teodorescu et al., 2019). The material Agar-agar is also used to modify the starch and it plays an almost

similar role as the PVA. In order to prevent the starch from getting affected by fungus or bacteria easily as it is an organic product; acetic acid is also used to prepare the biodegradable plastic (Vidra & Németh, 2017). Glycerin is used to control the moisture content in the biodegradable plastic. However, distilled water is used to make the overall solution of starch and other chemical and auxiliaries. The main focus of this project is to find an optimal recipe for manufacturing biodegradable plastic as a replacement of regular plastics, with high-quality properties by working with different combinations of the chemicals and auxiliaries. In order to create the biodegradable plastic different processes like solution preparation according to different recipes, film formation, polymerization and curing process are needed to be done. In this project the main work is done with four different recipes and four different biodegradable plastics have been created. Among those plastics one of them has shown very promising physico-mechanical properties. Further investigations have been done on that particular biodegradable plastic to learn its characteristics.

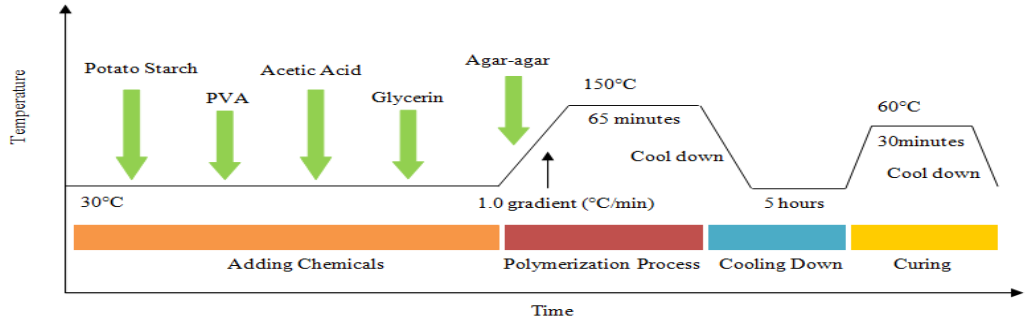

Figure 1: Biodegradable plastic Process curve

Results: Different physical tests like Tear strength, Tensile strength, Stiffness, GSM, Melting point, Water vapor transmission have been done of the specific biodegradable plastic to understand and inspect the physico-mechanical properties. The main goal is to find an alternative of regular plastic through this project, so it is important to make a comparison of this plastic with regular plastics. A regular plastic with same GSM as the biodegradable plastic has been taken and all the physico-mechanical tests which are mentioned before are done to the regular plastic. Test results are then compared with each other to understand how much compatible the new biodegradable plastic is against the regular plastic. In order to investigate the chemical composition of the biodegradable plastic Fourier-transform infrared spectroscopy (FTIR) test has been done on the biodegradable plastic (Eikrem, 1990). Most importantly biodegradability test has also been done on the biodegradable plastic to understand the biodegradable property of the plastic. In order to do the biodegradability test four different bacteria are collected and isolated from the regular soil sample. Then those bacteria have been cultivated and with the help of those bacteria culture the biodegradable plastic has been tested four different times to understand how much biodegradable the plastic is to each bacterium. The test results from the physico-mechanical properties of the biodegradable plastic have shown a significant amount of mechanical strength in the biodegradable plastic in comparison to the regular plastic. The biodegradable has comparatively higher melting point and lower water vapor transmission rate which relate it to the regular plastic. FTIR and biodegradability test ensure that this biodegradable plastic is made of organic materials and it will pretty much get degraded in environment soon after disposal. The test results provide a better understanding of the biodegradable plastic in comparison to the regular plastics.

Conclusion and Future Studies: In this project work an effort is made to develop a biodegradable plastic from potato starch based material. This new biodegradable plastic has shown a very promising start with good physico-mechanical properties. However, further developments can be done in order to increase its strength, and improve the dimensional stability and chemical resistivity so that it can be used in different complicated purposes.

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