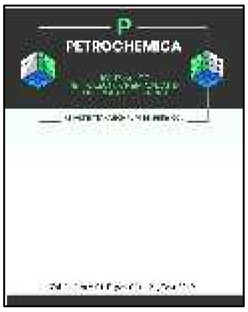

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Green Synthesis and Properties of Bioplastic Produced from Gelatin and other Waste Materials

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Abstract:

The disposal problems associated with conventional oil-based plastics constitute grave environmental menace across the globe considering the amounts churned out as waste on a regular basis. Bearing in mind that some plastics (particularly thermosets) are not recyclable, the recycling option faces additional problems of high energy consumption and difficulties arising from contaminants and fibre reinforcements. In addition, the option of recycling is becoming increasingly impractical with the production of complex multi-phased products. The container and packaging category constituted the highest tonnage. This is quite understandable since these products are mostly single-use items.Therefore, the current revolution taking place in the plastics industry is aimed at developing novel plastics possessing material properties comparable to their conventional counterparts coupled with the added advantage of biodegradability. Tremendous efforts are indeed underway towards building and perfecting this new generation of plastics tagged bioplastics or “green plastics” with renewable resources as the base materials This project explains production of bio-plastics fromgelatinand waste materials like Eggshells, Bagasse, Newspapers, Rice straw.

Keywords: Bioplastic, Biowaste, Environmental Pollution

1. Introduction

In recent years biodegradable plastics have wide applications in food packaging and biomedical science. These eco-friendly polymers replace the usage of petroleum-based synthetic polymers due to their biodegradability and low production cost. Biodegradable polymers broaden the range of waste management treatment over synthetic polymers. These polymers can be disposed by domestic and municipal composting instead of landfill which is the worst disposal option. Biodegradable plastics can be decomposed in soil or water with in the few months or years. However, these plastics can also be recycled. In 2005, the US alone generated about 28.9 million tons of plastic waste (11.8% of the total 245.7 million tons of municipal solid waste) with only a very small amount of about 1.7 million tons (5.7% of the total plastic waste) recovered for recycling while discarding the remaining 27.3 million tons (about 16.4% of the total municipal solid waste discards) to landfills. There were studies of the important properties of these plastics including mechanical strength, shear, impact resistance, ductility, transparency, fabricating versatility and moldability. Hence, production of bio-plastics become a need of hour.Gelatin, the main source of this bio-polymer has film forming nature. It can slowly dissolves in water and sets to a gel on cooling. Substance like calcium carbonate gives mechanical strength to the bio-polymer. Gelatin and calcium carbonate together makes a degradable polymer with appropriate strength. Glycerol used in this process act as a plasticizer. Hence, the plastic is produced in a fluid form and therefore, it is shaped easily to the required form and does not require large amount of energy when compare to the synthetic plastics. Because, synthetic plastics which is stored usually as granules and requires massive amount of energy to remoulding. In addition, this class of plastics is capable of significantly reducing environmental impact such as energy consumption and greenhouse effect in certain applications. The objective of this work aims to demonstrate the sustainable, economically viable materials for the preparation of degradable polymer and also to preserve our precious environment. The main innovative of this study includes the preparation of calcium carbonate from waste egg shell and glycerol from by-product of biodiesel production. Moreover, this work investigated and evaluated the degradable polymer for molecular weight, biodegradability, resistance for acids and alkalis.

2 MATERIALS

Calcium carbonate is obtained from eggshell where eggshells are collected from food industries as a waste. Glycerol is obtained as by-product of biodiesel production process carried out in the Department of Petrochemical Technology laboratory, University college of Engineering, BIT-Campus, Anna University, Tiruchirappalli. Gelatin and other material like vinegar are purchased from M/S. Priya BioScience laboratory Chemicals, Tiruchirappalli.

3 METHODS

3.1 Addition of the Ingredients

Fig.1 shows the grapical representation of sequential steps invoved in the production of biodegradable Bio-plastic. Combine all of the ingredients in the beaker and stir until there are no clumps left. Place the beaker on the mantle and start heating the mixture on medium to high heat. At this stage colouring ingredients (preferably few drops of food colouring agent) can be added if necessary.

3.2 Heating

Heat the mixture to 95°C (203°F) or until it begins to froth. Put the thermometer into the mixture and monitor the temperature until it reaches approximately 95°C (203°F) or begins to froth. If the mixture begins to froth before it reaches temperature, then that can be removed and degassing can be done to remove air bubbles in the plastics. Remove it from the heat when it either reaches temperature or starts frothing. Continue to stir the mixture while it is heating up.

3.3 Moulding

After removing the beaker from the heat source, excessive froth will be removed. Stir everything to remove all clumps from the plastic. Pour the plastic into a mould and leave the plastic to harden for at least two days. The amount of time it will take the plastic to harden is dependent upon the thickness of the mould. Generally, it will take at least 24 h to 48 h for dry and harden.

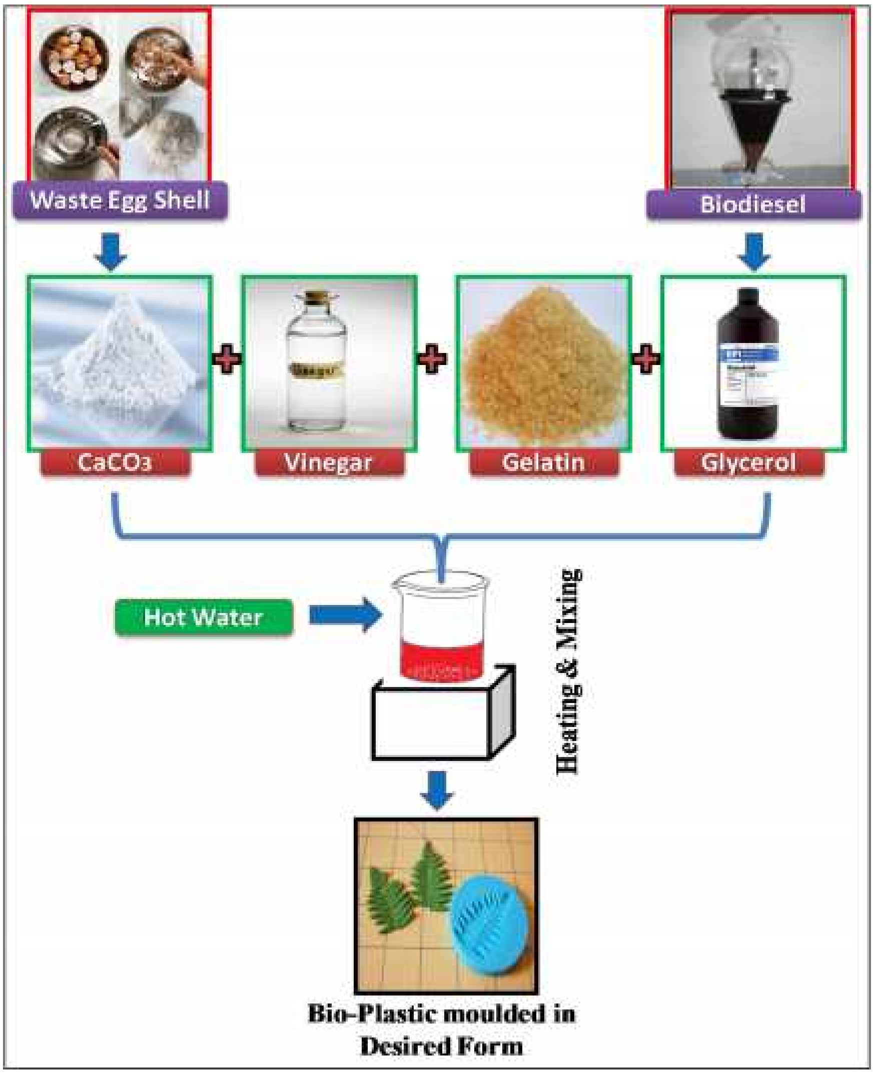

Figure 1 Grapical representation of sequential steps invoved in the production of biodegradable Bio-plastic

Drying time can be reduced when the plastic is kept inside the oven at higher temperature. It's easiest to leave the plastic undisturbed for a few days so it can dry on its own. Once the plastic hardens, it can no longer be moulded or shaped. If you want to shape it, you must do it while it is still warm and mouldable conditions.

4 RESULTS AND DISCUSSION

4.1 Determination of Density

The density of the produced polymer is determined by Archimedes' principle. The principle states that "the buoyant force on a submerged object is equal to the weight of the liquid displaced by the object". For water, with a density of one gram per cubic centimetre, this provides a convenient way to determine the volume of an irregularly shaped object and then to determine its density.

Mass of object-Apparent mass when submerged = Density of water × Volume of object

By Archimedes' principle, the density of the produced biopolymer is determined. The density of the produced biodegradable polymer is about 1.5 gm/cm^3.

4.2 Solvent Resistance Test

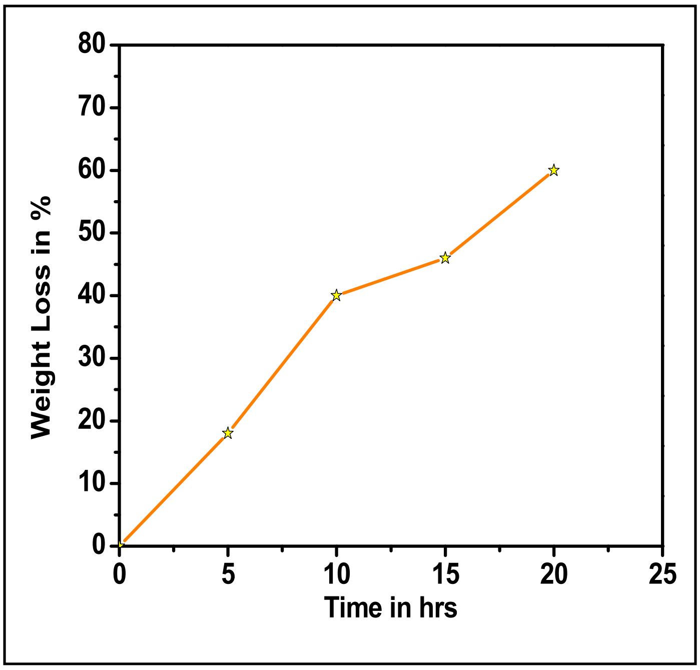

Figure 2 Weight loss of polymer in water

Sample of produced polymer were washed, dried, weighed precisely and put into different solvents (water, benzene, petrol and kerosene).The samples were dried and weighed periodically for 2 days in order to determine the percentage of weight loss after each time period. With the objective of making a comparison between the produced polymer and 2 of other known types of plastics.

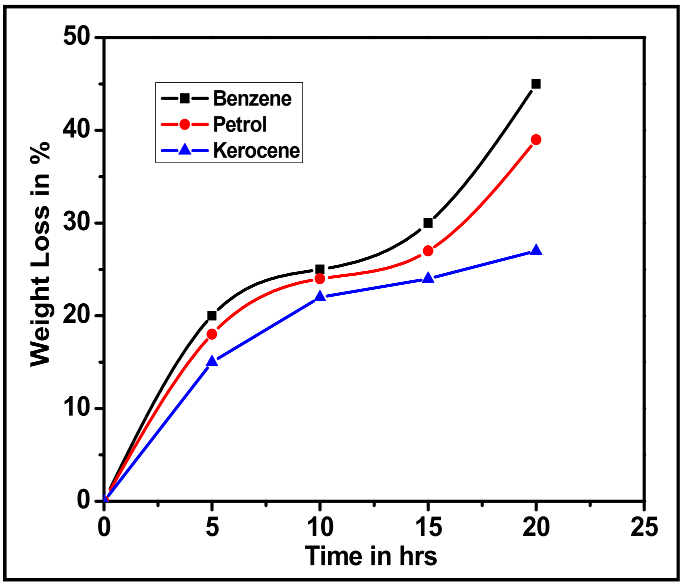

Figure 3 Effect of hydrocarbon solvents in weight loss of polymer

Fig. 2 and 3 represents the effect of water and other hydrocarbon solvent like benzene, petrol and kerosene in weight loss of produced bio-polymers.It is clear from the graph that, in the case of adding solvents to the produced polymer, the polymer lost weight after the few days and then the percentage of weight loss continue to increases over time in water and constant in aromatics. In addition, the increase in temperature of the solvents also increase the rate of weight loss of the polymer.

4.3 Effect of Acids

Sample of produced polymer were washed, dried, weighed precisely and put into different acid solutions (hydrochloric acid and sulphuric acid) with concentrations of 10-30%. The samples were dried and weighed periodically for 2 days in order to determine the percentage of weight loss after each time period. With the objective of making a comparison between the produced polymer and 2 of other known types of plastics.

Fig. 4 shows the results from the effects of sulphuric acid and hydrochloric acid at on produced biopolymer. The weight loss of polymer had been increased by increasing the concentration of sulphuric acid.

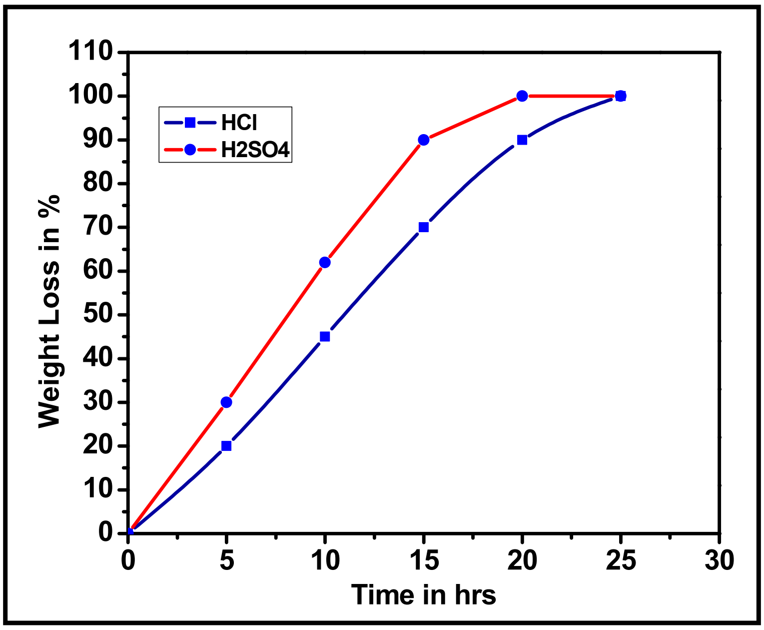

Figure 4 Effect of acids in weight loss of polymer

It seems that the biopolymer is completely dissolved in the acid as the time increases. As shown from the figure, the biopolymer is affected by acid to a much greater extent compared to polystyrene and polypropylene respectively. This means that the prepared biopolymer is less durable than polystyrene and polypropylene.

4.4 Effect of Alkalis

Sample of produced polymer were washed, dried, weighed precisely and put into alkali solution (sodium hydroxide) with concentrations of 10-40%. The samples were dried and weighed periodically for 5 days in order to determine the percentage of weight loss after each time period. With the objective of making a comparison between the produced polymer and 2 of other known types of plastics.

Fig. 5 represents the effect of alkali and other salts in weight loss of polymer. The test showed that alkali solution (sodium hydroxide) had no effect on this biopolymer where it did not show any noticeable weight loss when submerged in alkali solution. This showed that this biopolymer have an excellent resistance to the alkalis. Hence this can be an alternative for polypropylene and polystyrene which also have great resistance against alkalis.

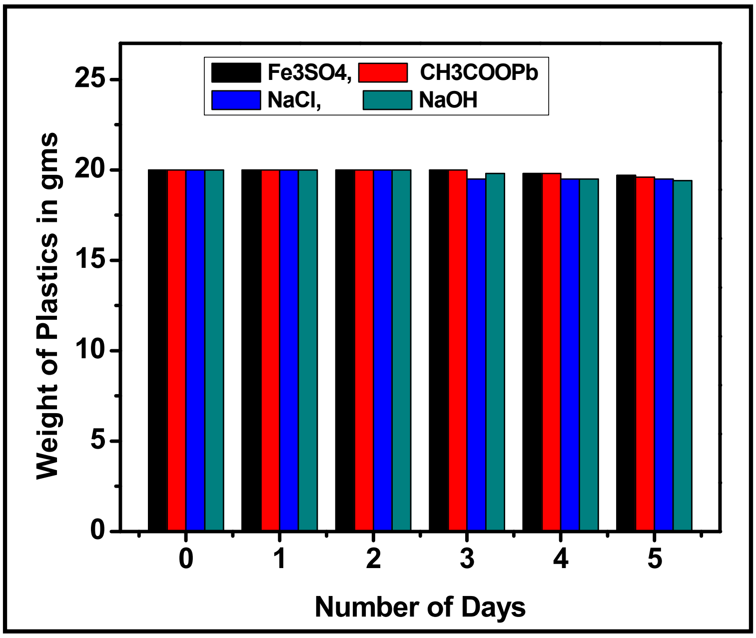

Figure 5 Effect of alkali and other salts in weight loss of polymer

4.5 Effect of Salts

The polymer produced was mixed with solid salts (sodium chloride, ferrous sulphate, lead acetate) and left for 5 days, with periodic weighing everyday, with the objective of determining its resistance to the action of salts. Samples of polymer weighing 5g were used and everyday the polymer was removed from the salt, thoroughly washed, dried and weighed.

The test showed that the solid ferrous sulphate, sodium chloride and lead acetate had no effect on produced polymer where it did not show any weight loss when mixed with these salts for five days. This shows the produced polymer have an excellent resistance to the salts . Also, this polymer could be an alternative to using polyethylene which is used commonly for manufacturing containers for salts.

5 CONCLUSIONS

The eco-friendly natural biopolymer was successfully prepared by using gelatin& calcium carbonate. Also characterised by using varies instrumental techniques and environmental properties tests. This acceptable overall performance, shown by this biopolymer, has put it forward as a suitable material for packages, salt containers, fiber and plastic tool manufacture. Thus the biopolymer has the potential to replace or minimize the use of non-biodegradable and petroleum-based material.

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