A Study on the Characterization and Utilization of the Banana Peel, Shells of Egg and Prawn for the production of Bioplastics

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Abstract

Growing level of pollution from the industrial waste or any other form of waste in the environment caused the hazardous effect on the mother planet earth. Plastic pollution played an important role in causing the hazardous effect in both terrestrial and aquatic environment. The entire ecosystem were affected by the pollution. As plastics were non-biodegradable, unsustainable, eco-toxic, increases global warming, leads to biotic and abiotic depletion and reduces the soil fertility. This study were aimed to determine the alternatives for the usage of plastics. As bioplastics were substituted the usage of conventional plastic because they were biodegradable, more sustainable, non-toxic, eco-friendly, no harm to biotic and abiotic factors, increases the soil fertility. These biodegradable plastics were made from the waste materials, such as fruit peels, shells of prawn and egg which acts as a raw material for the production of bioplastic.

Key words: Plastic pollution, Environment, Bioplastic, Fruit peels, Shells of Prawn and Egg.

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1. Introduction

India generates 25,490 tonnes of plastic waste everyday, but 40% of it remains uncollected, causing choking of drainage and river systems, littering of soil and water pollution, ingestion by stray animals and open air burning leading to adverse impact on human health and environment [6].The accumulation of plastic and products made of plastic in the environment led to the plastic pollution which caused the harmful and dangerous effects on the wild life, marine life and human food chain. These plastic have a chemical characteristic features by which they are resistant to environmental degradation. Bioplastics are the one of the important remedy to overcome the problem of plastic waste, thereby creating an environmental friendly alternative to the conventional plastics.

1.1 Bioplastics

Bioplastics are the form of plastic that can be derived from biological sources and are biodegradable. As they are the biodegradable plastics which can be degraded by microorganisms and are produced from plant derived compounds, such as starch, chitosan and lignin [2]. Bioplastics and biocompatible polymers are gaining importance worldwide in both basic and applied research fields such as pharmacological, biomedical and environmental applications [2]. Chitosan is a linear polysaccharide composed of randomly distributed β-(1→4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit) [4][8]. It is a helical polysaccharide macromolecule found in the exoskeleton of crustaceans such as crabs, shrimp, crawfish, insects, and other arthropods. Starch is the promising material for plastic raw material because its characteristics are universal, biodegradable and has affordable price [5].

Glycerol acts as a gelling agent for the production of Bioplastic. Therefore, the demand for alternative for plastic is emerging globally due to the fact of safeguarding the earth from pollution and thus, the application of bioplastics prepared from plant sources of waste fruit peels can be considered as a better alternative to synthetic plastics.

2. Materials and Method

The Fruit peels, Egg shells were collected from the Hotels and from nearby houses and Prawn shells were collected from the Seafood shops, located near the banks of the Vaigai river.

2.1 Extraction of Starch

The Selected fruit peels were weighed and cleaned, cut into small pieces using a knife and then homogenized with the distilled water containing sodium metabisulphite (0.3%) at a proportion of selected fruit peel:distilled water(1:2)[7]. The resulting homogenate were filtered, squeezed using a filter cloth and collected in the container. Filtrate were kept for 24 hours, yielding a complete starch sediment. The starch from all samples were collected by decantation and it were subsequently dried in an oven (40-60°C) for 24 hours. The dried starch were grounded and screened through 24-mesh sieve [7]

2.2 Extraction of Chitosan

Chitosan from all samples were prepared from the eggshell and prawn shell waste. Biomass of prawn shell waste and eggshell waste were collected (5 grams). Then they were washed and cleaned using tap water and allowed them to dry. Then it was deproteinised in 4% aqueous Sodium hydroxide (1:4.5; w/v) at 25^0C (room temperature) for 21 hours. After draining the alkali, the residual protein were removed from the shell. Then, they were washed using distilled water repeatedly unless the pH drops to neutral. Then, these both shells were demineralized by 4%HCl (1:4.5; w/v) at 25^0C (room temperature) for 12 hours [1].

Then the acid were drained off and again washed thoroughly with the distilled water. Chitin were dried at a ambient temperature (30 ± 2^0C). Chitosan were prepared by deacetylation of chitin by treating with 50% aqueous Sodium hydroxide (1:20; w/v) at 40^0C for 3 days. The alkali were drained off and washed thoroughly with distilled water until the pH is less than 7.5. Finally, the chitosan were dried at ambient temperature (30 ± 2^0C) [1].

2.3 Synthesis of Bioplastic film

7gm of extracted starch and 3 gm of chitosan from eggshell / prawn shell were weighed, which are of 10 gm. Starch solution were made by dissolving starch in 100ml of distilled water. Chitosan solution were made by dissolving chitosan in 100ml of acetic acid. Starch solutions were taken in the beaker and heated it gently.

Then 2ml of glycerol were added into it. Then the solutions were added with chitosan solution [5]. After that the sample were begins to form the gel. Then the samples were poured into the mold and dried over the hot plate at 75^0C and bioplastic films were obtained.

3. Result and Discussion

3.1 The Collected Fruit peel, Prawn shell and Egg shell

Fig:1 Banana peel

Fig:2 Prawn shell

Fig : 3 Egg shell

3.4 Extraction of Starch:

From fig (4), it was observed that the dried starch was extracted from the Banana peel and it was grounded. The extracted starch was brownish white, odourless and tasteless. However, the colour of the resulting banana peel starch has yet to be improved for it still appeared as brownish white powder. This might due to an oxidation process occurring during the preparation of starch.

Fig: 4 Extracted starch from the banana peel

3.5 Extraction of Chitosan

3.5.1. Extraction of chitosan from Prawn shell

Fig 5: Chitosan was extracted from the Prawn shell

3.5.2 Extraction of Chitosan from Eggshell:

Fig 6: Chitosan was extracted from the Egg shell

From fig (5,6), it was observed that chitosan from the Prawn shell and Egg shell were extracted by the process of demineralization, deproteinization, deacetylation of chitin and the dried chitosan was collected and grounded. The Extracted chitosan were white colour, odourless and tasteless. Chitin, the second most abundant biopolymer after cellulose [3]. Chitosan is the natural biopolymer derived by deacetylation of chitin.

3.6 Synthesis of Bioplastic film

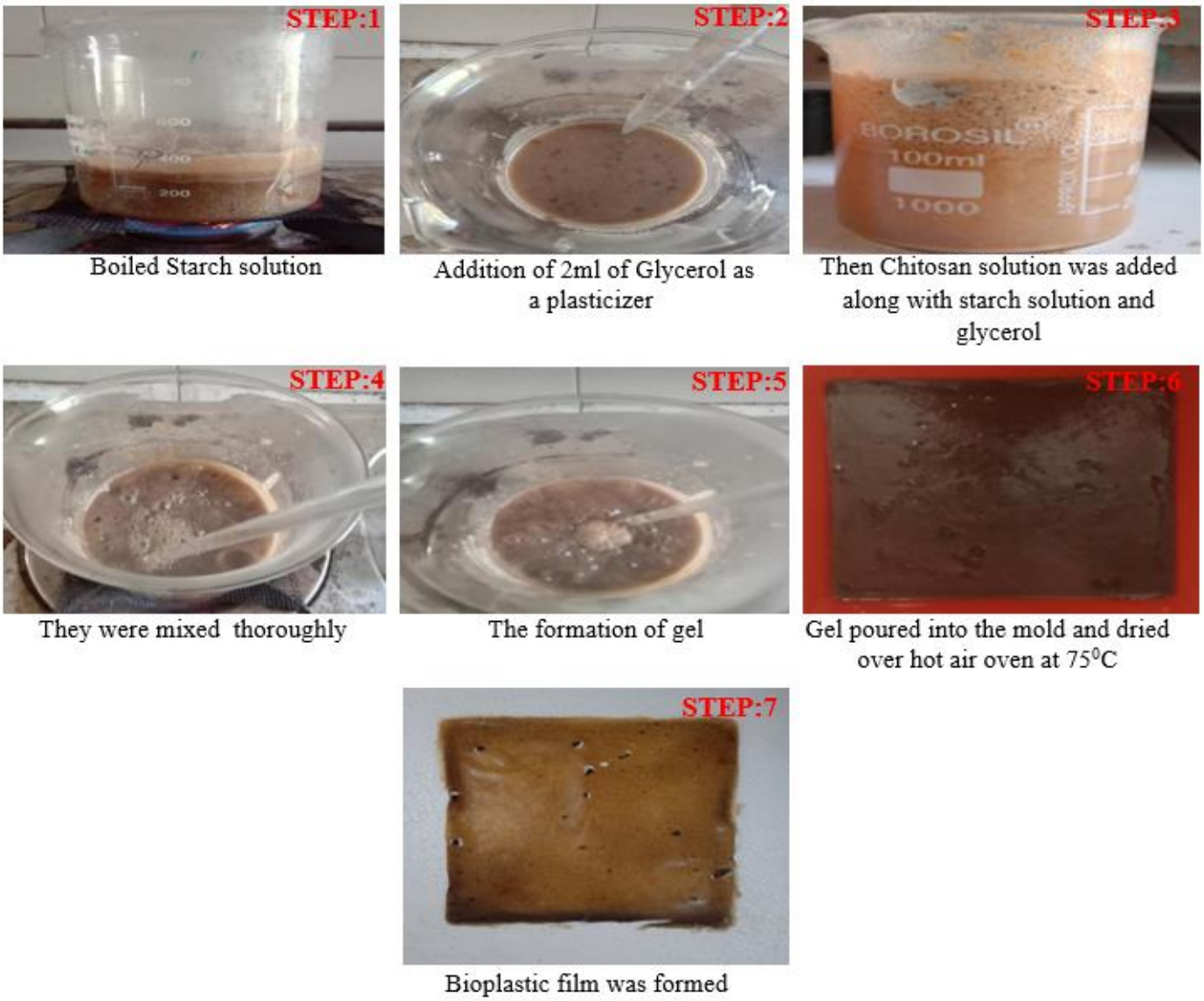

Fig: 7 The Bioplastic film was synthesized from combination of starch, chitosan and glycerol

3.7 Four different forms of Bioplastic films:

From fig (7, 8), it was observed that the synthesized bioplastic were of four different bioplastic films with different composition. The Bioplastic film C was very hard, transparent and they were white in colour and made up of commercial starch, commercial chitosan. The bioplastic film B1 was smooth, transparent and brown in colour, made up of banana peel starch and prawn shell chitosan. The bioplastic film B2 was also smooth, transparent and it was dark brown in colour. They was made up of banana peel starch and egg shell chitosan. The bioplastic film B3 was hard to touch, translucent and it was also dark brown in colour and made up of banana peel starch, prawn shell chitosan, and egg shell chitosan. And all the bioplastic films were made up of polymers of Starch and Chitosan with glycerol as a plasticizer. Plasticizers were generally small

molecules and established strong interaction between the polymer chains, by intercalating the hydrogen bonding between the starch and chitosan and this property helps to form the film like appearance to form the bioplastic film. The formed bioplastic films were flexible. These films were easy to handle and it was an eco-friendly material.

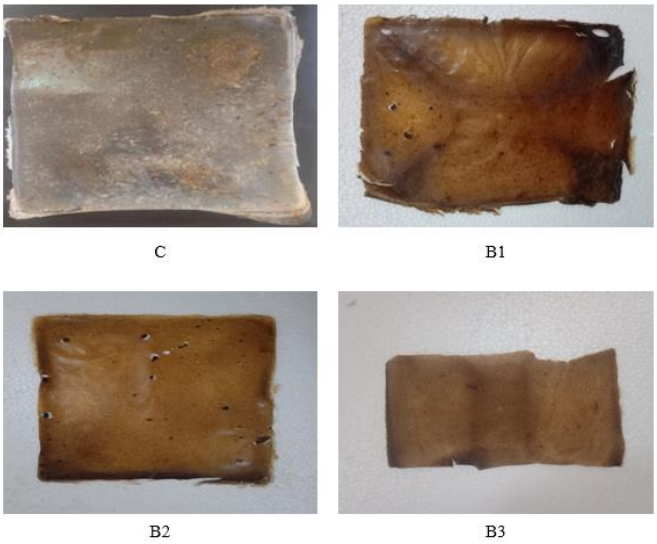

Fig: 8 The four different forms of Bioplastic films were made with various composition of starch, chitosan and glycerol, in natural and commercial forms.

4. Conclusion

The present investigation on "A study on the characterization and utilization of the banana peel, shells of egg and prawn for the production of Bioplastics" highlighted the following:

As bioplastics are the one of the important remedies to overcome the problem of plastic waste, thereby creating an environment friendly. They are eco-friendly, biodegradable and compostable. Theyhave the characteristic feature of plastic, hence they can be used to replace the plastic. They have the wide application in the field of agriculture, biomedical and environmental application. The process of extraction of starch and chitosan was taken longer period of time.

As the production rate was in higher quantities, then the bioplastic would be of lower cost and it would break the record of conventional plastic. Therefore, the demand for alternative for plastic is emerging globally due to the fact of safeguarding the earth from pollution and thus, the application of bioplastics could be considered as a better alternative to conventional plastics.

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