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# Production of Bioplastic from Biowaste Materials and Its SEM-EDS Report

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***Abstract:*** ***Plastics are petroleum based polymers that cannot be degraded naturally. One environmental friendly alternative to the current plastic is bioplastic. Bioplastic are biodegradable plastics which can be degraded naturally. Many raw materials have been investigated for the production of these bioplastics. In this work, three different raw materials such as gelatin, agar and starch which were extracted from waste biomaterials and were used in different proportions for the production of bioplastic. Properties of bioplastics such as solubility, folding endurance, elongation strength, melting point, hardness, biodegradability and SEM EDS were performed and it was found that the produced bioplastic was insoluble in water, polar and non-polar solvents. The elongation strength of bioplastic was found to be 17.64% and 15 folds were able to perform. The melting point of bioplatic was found to be 90°C and the biodegradability of the bioplastic was analyzed and 60% degradation was found within 25 days. The hardness of the bioplastic was found to be 30. The molecular structure and composition of the bioplastic was analyzed by SEM and EDS test and the results revealed that complete mixing of raw materials in SEM image hence showed smooth surface.***

***Index Term: Bioplastic, Gelatin, Agar, Starch, Solubility, Elongation, Hardness.***

## I. INTRODUCTION

Plastics turn to a part and parcel of our day to day life. Though it has numerous applications, over usage of plastics cause more serious environmental problems like pollution and even cause cancer in humans[1].Plastic waste totally produced annually was accounted as 5.9 million tones[2]. All these plastics are the reason main environmental hazards and harms the ecosystem[3]. Mainly plastics are derived from fractionation of petroleum. Because of depletion of fossil fuel, brought people's concern to find out an alternate to plastic. Producing biopolymer using microbes is usually very costly. Thesepetroleum based plastic waste cause a serious problem to wildlife, landscape and marine animals[4].

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Accumulation of these plastic due to the dumping of large amount of plastics in
ocean for many reasons. Effect of these dumped plastic in to marine ecosystem have been studied by Ryan et al[4].
Apart from this, plastic wastes are also affecting the ecosystem and ature[6]. Natural polymers or biopolymers are those present in the natural environment by living organisms and they are usually extracted from plants or animals.
Proteins, polysaccharides and natural rubber are all examples of natural polymers. Now research has been focused on producing biopolymers as an alternative to oil-based plastics and is applied for numerous field. Bioplastic is generally produced by melting the starch at high pressure and heat. These are formed as thermoplastic and are a great revolution in the green plastic world. These bioplastics are differentiated from petroleum based plastic from is its biodegradability that makes them unique. These bioplastics never leads to pollution since they are produced from biomasses and never contain toxic material. They are also eco-friendly in nature[7-9]. Many starch materials such as jackfruit seeds, corn have been found out for the best alternate for producing bioplastic[10]. Starch was also to be found an alternate raw material for the production of bioplastics as it has low cost[11].

## II. MATERIALS AND METHODS

### *A.Extraction of source materials*

The main sources such as starch, gelatin and agar which were used for producing bioplastics were extracted from waste materials such as rice soaked water, waste scales from thilapia fish and seaweeds.

### *B.Extraction of Starch*

Estimated amount of rice soaked in 200ml of distilled and the starch was allowed to settle. The ratio of rice and water to get the starch was of maintained about 1:4.

### *C.Extraction of Gelatin*

An amount of waste fish scales were collected from local fish market and washed thoroughly with water to remove other unwanted particles present in it. Then it was soaked in NaOH (0.4 w/v) for 4 hours to remove collagenous protein. After that it was rewashed with tap water for 1 hr. Then it was soaked in HCl to neutralize it. Again it was washed with running tap water. Then distilled water was added to it and was heated at 70°C for 90 min. Then it was filtered by muslin cloth to separate gelatin.

***D.Extraction of agar***

Maine algae *Gracilaria sp.*, was collected from Rameshwaram, Tamil Nadu. Then it was washed with water to remove epiphytes and was dried under sun light for the complete removal of moisture. Two gram of agar was soaked in 120 ml of water for 24 hrs. Then it was ground well and was filtered. Then the filtered pulp was boiled for 2 hrs in 100 ml of distilled water and was filtered. Then it was cooled to room temperature.

***E.Production of bioplastic***

Starch, agar and gelatin was taken in the ratio of 1:1:1 and was mixed with 1% glycerol. Then 100 ml of distilled water was added to it and was heated with constant stirring until the mixture becomes viscous. Then it was poured on aluminium foil to get thin film.

***F.Solubility test***

Two gram of bioplastic film sample was taken in a 50ml beaker and it was dissolved in 50ml of three different solvents such as water, ethanol and chloroform and the solubility was analysed after 3 hrs of soaking.

***G.Elongation test:***

Elongation test was performed by holding the bioplastic film at one end and the other end was slowly pulled until it broke down. Ruler was placed near the film and the initial and final length was measured.

$$\% \text{ Elongation } = \frac{\Delta L}{Lo} * 100$$

Where ΔL = Change in length

Lo = Original length

***H.Folding endurance test:***

The bioplastic film was taken and was folded equally until it breaks. Then it was unfolded and the number of folding was counted.

***I.Biodegradability Test:***

Two gram of sample was placed on 20g of soil sample for 25 days. Then the final weight of sample was measured.

% Degradation = ( (Initial weight of plastic – Final weight of sample) / Initial weight)*100

***J.Hardness Test:***

Hardness of the sample was tested by rock well hardness testing machine.

***K.SEM and EDS***

Surface morphology of plastic was analysed by SEM-EDS in SRM University, Ramapuram. The sample as analysed under different magnification such as ×100, ×500, ×750, ×1.0K,×2.5K, ×3.5K.

## III. RESULTS AND DISCUSSION

Now a day, utilization of plastic is increasing very fast. Since these plastics are made up of petroleum derivatives it causes severe damage to the environment. Hence there is an urge for the production of alternate plastic which could be decomposed easily and ecofriendly. Bioplastics are one of the best alternate for synthetic plastics. In this work, different sources have been used for producing biologically degradable plastic (Fig.1)

***L.Agar-starch-gelatin bioplastic***


**Fig.1 Bioplastic**

***M.Solubility test***

The produced bioplastic was found to be insoluble in all solvents used in this study (Table.1)

**Table.1 Solubility test for bioplastic**

| S. No | Solvent | Time of Soaking (hr) | Solubility |
|---|---|---|---|
| 1. | Water | 3 | Not soluble |
| 2. | Ethanol | 3 | Not soluble |
| 3. | Chloroform | 3 | Not soluble |

***N.Elongation test***

The maximum elongation of bioplastic was found to be 17.65%. This may be due to in sufficient addition of plasticizers (Table.2) (Fig.2).

**Table.2 Elongation strength**

| S.No | Type of bioplastic | Original Length | Change in length | % Elongation |
|---|---|---|---|---|
| 1 | Gelatin starch Agar | 6.8 | 1.2 | 17.64 |

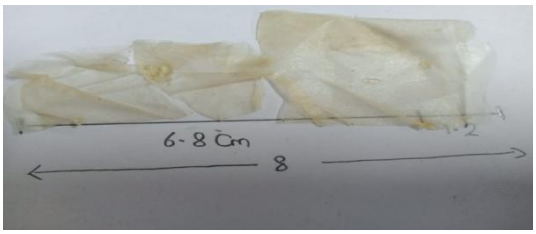



**Fig.2 Elongation**

***O.Folding endurance***

Folding endurance is to check the durability of the plastic. It is the number of double folds required to make a test piece break under standardized conditions. There were 15 folds could be made by the produced bioplastic (Table.3)

**Table.3 Folding endurance**

| S. No | Type of bioplastic | Number of folds |
|---|---|---|
| 1. | Gelatin-agar-starch | 15 |

***P.Melting point***

Melting temperature is highly important for plastic in order to mold them. Gelatin-starch- agar bioplastic has the melting point of about 90̊ C. (Table.4)

**Table.4 Melting Point**

| Sl. No | Type of bioplastic | Melting point |
|---|---|---|
| 1 | Gelatin-agar-starch | 90°C |

***Q.Biodegradability***

After 25 days the weight of the bioplastic is being reduced from 2g to 0.79g.Biodegradation of bioplastic is being observed to be 1.21g and % degradation was found to be 60.5%

***R.Hardness Of The Bioplastic Product***

The hardness of the bioplastic is being calculated using an instrument Rockwell hardness testing machine. The hardness of the bioplastic was found to be 30 (Table.5).

**Table.5 Hardness**

| SCALE | LOAD | INTENDOR | DIAL |
|---|---|---|---|
| HRA | 60Kgf | DIAMOND | BLACK |
| HRB | 100Kgf | 1/16 BALL | RED |
| HRC | 150Kgf | DIAMOND | BLACK |

***S.SEM and EDS***

SEM analysis exhibited the surface structure of the produced bioplastic and it was found to be smooth and little bit crack was found in some place which might have occurred due to the incomplete mixing of raw material hence it lost its smoothness, and cracks were evident. The image also showed that good adhesion between the starch-agar and gelatin and also with plasticizer (Fig.3 -9).

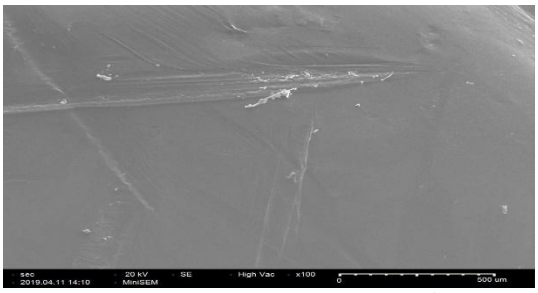


**Fig.3 Bioplastic SEM image at ×100 magnification**

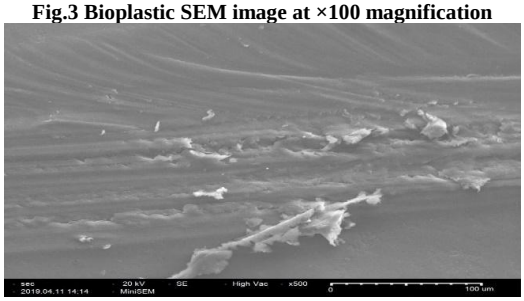


**Fig.4 Bioplastic SEM image at ×500 magnification**

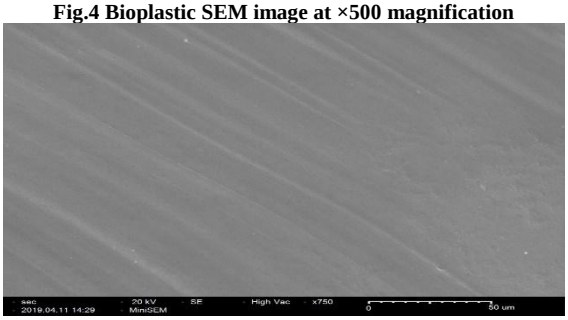


**Fig.5 Bioplastic SEM image at ×750 magnification**

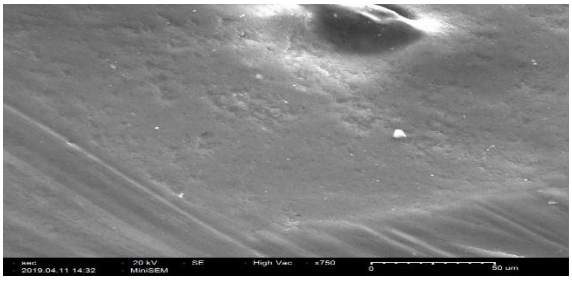


**Fig.6 Bioplastic SEM image at ×750 magnification**

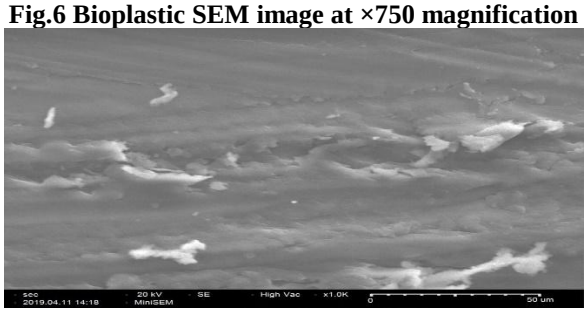


**Fig.7 Bioplastic SEM image at ×1.OK magnification**

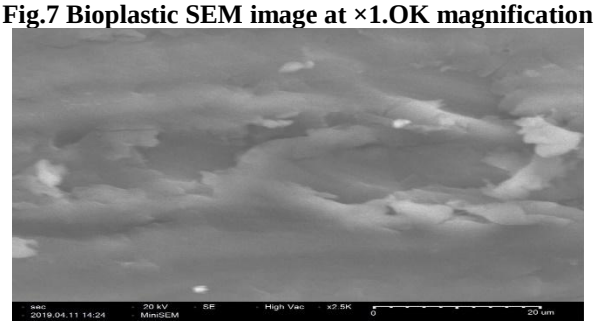


**Fig.8 Bioplastic SEM image at ×2.5 K magnification**

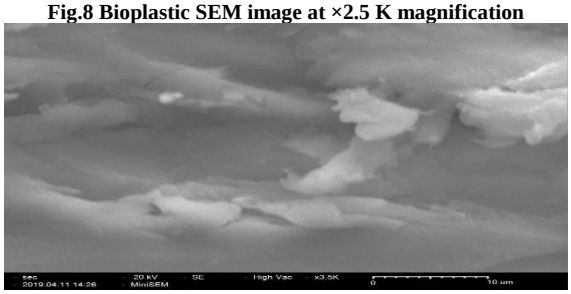
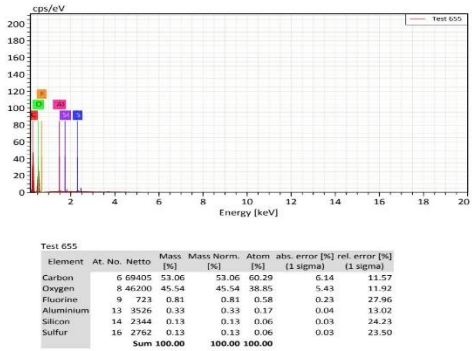


**Fig.9 Bioplastic SEM image at ×3.5 K magnification**

EDS can be used to determine which chemical elements are present in a sample, and can be used to estimate their relative abundance.




Test 655

| Element | At. No. | Netto | Mass [%] | Mass Norm. [%] | Atom [%] | abs. error [%] (1 sigma) | rel. error [%] (1 sigma) |
|---|---|---|---|---|---|---|---|
| Carbon | 6 | 69405 | 53.06 | 53.06 | 60.29 | 6.14 | 11.57 |
| Oxygen | 8 | 46200 | 45.54 | 45.54 | 38.85 | 5.43 | 11.92 |
| Fluorine | 9 | 723 | 0.81 | 0.81 | 0.58 | 0.23 | 27.96 |
| Aluminium | 13 | 3526 | 0.33 | 0.33 | 0.17 | 0.04 | 13.02 |
| Silicon | 14 | 2344 | 0.13 | 0.13 | 0.06 | 0.03 | 24.23 |
| Sulfur | 16 | 2762 | 0.13 | 0.13 | 0.06 | 0.03 | 23.50 |
| | | Sum | 100.00 | 100.00 | 100.00 | | |

**Fig.10 Bioplastic EDS graph**

In EDS analysis, compounds such as carbon, oxygen, fluorine, aluminium, silicone and sulfur were found in bioplastic (Fig.10).

## IV. CONCLUSION

As environment is been highly polluted by petroleum based plastics, bioplastics industries have boomed because of its cost effective and also its easily degradable nature. Bioplastics industries have many advantages such as saving of fossil fuel, protection of climate and also it is proving jobs. Since the bioplastics are made from a renewable sources, they are found as more ecofriendly than nonrenewable conventional plastics.

In this work the bioplastics were produced using raw materials such as gelatin, starch and agar and their various parameters were studied. In future, parameters may be optimized to strengthen the bioplastic and to increase percentage of degradation. Economic points may also be considered to commercialize the bioplastic.

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