Production and Characterization of Bioplastic from Phycocolloids

Avanti P. Karande¹, Sneha M. Patil², Mahananda B. Gurav³, Mahadev S. Mhetre⁴, Sandip S. Fundipalle⁵ and Rukmini D. Potdar⁶

¹Student, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA
²Student, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA
³Student, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA
⁴Student, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA
⁵Student, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA
⁶Professor, Department of Biotechnology, V. G. Shivdare College, Punnyahlokh Ahilyadevi Holkar Solapur University, Solapur (PAHSUS), INDIA

Corresponding Author: awanti13899@gmail.com

ABSTRACT

Plastic that is made partly or wholly from polymer derived from biological sources such as sugarcane, potato or starch is called bioplastic. It is bio based, biodegradable or features both the properties. The use of Bio plastic is growing rapidly because of their clear advantage over traditionally used plastic. Bio plastic can be used in packaging industries, in the making of capsules and pills, mobile cases, for making baby toys, etc. The main aim of this study was to identify the potential use of agar (Phycocolloids) in the making of bio plastic. The term phycocolloid is used to described a colloid derived from seaweed; a colloid in turn is defined as a non crystalline substance with very large molecules. A phycocolloid is thus simply a seaweed gum. The results of current study show that agar can be successfully used for making bio plastic.

Keywords - Agar, Glycerine, Water, Bioplastic, Phycocolloids

I. INTRODUCTION

Now a days seaweed has received much interest and application related to biosensors, food etc. Similar to other polysaccharide material seaweed also is useful because, it is an inexpensive source of polysaccharide harvested from sea. Alginate, carrageenan and agar are common seaweed. However, seaweed films have strong mechanical property compared to non-renewable polymers. So the seaweed is mixed with the other components to improve the properties of seaweed film.

II. MATERIALS AND METHODS

For preparing the agar bio plastic film, agar powder was used. The glycerine and water were used as plasticizer.

Bioplastic Preparation

Powder of commercial and algal agar (lab grade) with optimized concentration is used in the preparation of bio plastic. Varying concentrations of agar and glycerine were used and the strength or stretch ability of the bio plastic film obtained from it was checked. Glycerine is used as plasticizer, due to it’s better mechanical properties and good water solubility. The agar and glycerine was added to 100mL water in various ratio. The mixture was stirred for 10 to 15 min then the mixture was heated on conical flask for proper dissolving of agar. It was then poured onto a glass tray and steel tray and spread uniformly. It took 3 days for the mixture to dry out and the film was removed.

III. CHARACTERIZATION

1. Biodegradability Test:

The specimen was cut into pieces of the 4.0cm. And placed near the roots of plants 3cm deep in soil. 500g of soil was collected and stored in a container as control. Both the test and control samples were kept in same condition for 60 days.

Figure 1: Biodegradability of plastic.
2. **pH Of Soil**

After the biodegradability test, the pH of soil was checked and there was not much change in the pH of soil.

Normal soil pH = 7.71
Plastic dumped soil pH = 7.76

3. **Burning Test**

![Figure 2: Polythene burn bioplastic burn](image)

4. **Elongation**

It is related ability of a plastic specimen to resist changes of shape without cracking. It is checked with the help of following formula –

\[
\text{Elongation} = \frac{\text{Final length}}{\text{Original length}} \times 100
\]

5. **For Packaging**

The every piece of food today is packed in plastic packaging. The bad things is that, the packaging material is not biodegradable. Many people throw it away, but microorganisms cannot degrade them. Those food packages destroy the nature by causing pollution.

It is easy to avoid these problems by using biodegradable plastic and protect the nature and the future generation in turn from the harms due to the polluted environment.

The fruit *Psidium guajara* (Guava) are wrapped with polythene bag and bio plastic and kept at R.T for 1 week results obtained are as follows.

6. **Film Swelling Index**

Film samples with area of approximately 1 into 1 cm were weighted to find their dry weight. The samples were then immersed in at RT and removed for reweighing every hour for three hours.

- Initial weight = 0.110
- Final weight = 0.270

7. **Water Holding Capacity**

Because agar and glycerine has water holding capacity this property can be useful for plants.

For this, the bio plastic was dumped in one pot with soil and in another pot only soil was taken.

The tree was planted in both the pots at same time and it is observed that the pot with bio plastic requires less water as compared to the another pot.

|                | Control (polythene) | Sample (Bioplastic) |
|----------------|---------------------|---------------------|
| Initial weight | 0.500g              | 0.500g              |
| Weight after 1 month | 0.500g              | 0.350g              |
| Reweight after 2 months | 0.500g              | 0.12g               |

![Figure 3: Bioplastic dumped plant](image)
On the basis of observation table the agar bio plastic degrade very fastly as compare to polythene.

2. **The ph of soil** is checked and there is no effect of bioplastic on the ph of soil.

| Observation     | Normal polythene | Bioplastic          |
|-----------------|-------------------|---------------------|
| 1. Colour       | White             | Colorless           |
| 2. Flame colour | Blue yellow       | Yellow              |
| 3. Burning rate | It takes 6 to 7 min | Burns within a second |
| 4. Smell        | Pungent smell     | No any type of pungent |

3. **Burning test** was performed as compared to polythene bio plastic is less harmful.

4. With the help of **swelling index** it proved that bioplastic has ability to hold water.

5. On the basis of **elongation test** the bioplastic had good elasticity property. The glycerin concentration effects on bioplastic. It increases its elongation property. As the glycerine add more the bioplastic is more flexible and it is checked with the help of elongation test.

| Agar concentration | Glycerine concentration | Water concentration | Initial length | Final length |
|--------------------|-------------------------|---------------------|----------------|-------------|
| 2gm                | 2ml                     | 100ml               | 6cm            | 8cm         |
| 2gm                | 5ml                     | 100ml               | 6cm            | 12cm        |
| 2gm                | 12ml                    | 100ml               | 6cm            | 16cm        |

6. For packaging bio plastic was used and the microorganisms are not grown.

V. **DISCUSSION**

The increasing pollution now a days has become the issue of concern all around the globe since it is having the adverse effects on the living world. The use of plastic adds to this issue by leading to the increase in pollution of land (because of dumping it), air pollution (if it is burnt) or water pollution (when it gets mixed with water resources). The use of bioplastic can reduce this problem to the large extent since it never harms the nature or environment. However, the bioplastic should also possess the properties of traditionally used plastic like it should be flexible, it should get elongated, etc. And at the same time it should not harm the environment. Hence, the tests like the burning test, test foe water holding capacity or the one done for checking it’s applicability as packaging material proves that it is environment friendly, economical and also satisfies with the properties of traditionally used plastics.
VI. CONCLUSION

In this study, the obtained bioplastic made from agar is transparent, odourless. These preliminary experiments demonstrated that it may be a promising alternative for natural and biodegradable plastic.

ACKNOWLEDGEMENT

The authors would like to acknowledge the following: V. G. Shivdare College Department of Biotechnology all the teaching and non-teaching staff, Punyashlok Ahilyadevi Holkar Solapur University, Solapur (PAHSUS).

REFERENCES

[1] Amel Ismail, Wahiba Hammami and Fethi Mensi et Leila Ktari. (2015). Bioplastic from agar: Hydrophilic and thermo-mechanical properties. Bull. Inst. Nat. Sci. Tech. Mer. de Salammbo, 42, 17-19. Available at: https://www.oceandocs.org/bitstream/handle/1834/9039/10.pdf?sequence=1

[2] Hii, S., Lim, J., Ong, W., & Wong, C. (2016). AGAR from Malaysian red seaweed as potential material for synthesis of bioplastic film. Journal of Engineering Science and Technology, 11, 1-15.

[3] Tabassum, Asma. (2016). Biofilms from agar obtained from an agarophyte of Karachi coast. Pakistan Journal of Marine Sciences, 25(1&2), 37-40. Available at: http://aquaticcommons.org/26598/

[4] Jumaidin, Ridhwan & Sapuan, S. & Jawaid, Mohammad & Ishak, Mohamad & Sahari, J.. (2017). Effect of agar on physical properties of thermoplastic starch derived from sugar palm tree. Pertanika Journal of Science and Technology, 25, 1235-1248.

[5] Yaradoddi, Jayachandra & Patil, Vinay & Ganachari, Dr. Sharanabasava & Banapurmath, Nagaraj & Hunashyal, A.M. & Shettar, Ashok. (2016). Biodegradable plastic production from fruit waste material and its sustainable use for green applications. International Journal of Pharmaceutical Research and Allied Science, 5(6), 56-66

[6] Lubis, M., Gana, A., Maysarah, S., Ginting, M. H. S., & Harahap, M. B. (2018). Production of bioplastic from jackfruit seed starch (Artocarpus heterophyllus) reinforced with microcrystalline cellulose from cocoa pod husk (Theobroma cacao L.) using glycerol as plasticizer. IOP Conference Series: Materials Science and Engineering, 309, 012100. https://doi.org/10.1088/1757-899X/309/1/012100

[7] Tsang, Y. F., Kumar, V., Samadar, P., Yang, Y., Lee, J., Ok, Y. S., Song, H., Kim, K.-H., Kwon, E. E., & Jeon, Y. J. (2019). Production of bioplastic through food waste valorization. Environment International, 127, 625–644. https://doi.org/10.1016/j.envint.2019.03.076

[8] Gonzalez-Gutierrez, J., Partal, P., Garcia-Morales, M., & Gallegos, C. (2010). Development of highly-transparent protein/starch-based bioplastics. Bioresource Technology, 101(6), 2007–2013. https://doi.org/10.1016/j.biortech.2009.10.025