Production of biodegradable plastic by polyhydroxybutyrate (PHB) accumulating bacteria using low cost agricultural waste material

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Abstract:

Polyhydroxybutyrates (PHBs) are macromolecules synthesized by bacteria. They are inclusion bodies accumulated as reserve materials when the bacteria grow under different stress conditions. Because of their fast degradability under natural environmental conditions, PHBs are selected as alternatives for production of biode- gradable plastics. The aim of this work was to isolate potential PHB producing bacteria, evaluate PHB production using agro-residues as carbon sources. Ten PHB-accumulating strains were selected and compared for their ability to accumulate PHB granules inside their cells. The optimum pH, temperature, and incubation period for the best PHB production by the isolate were 7, 35 C, and 72 h respectively. The strain was able to accumulate when pretreated, with sugarcane bagasse, paper waste and rose petals were used as carbon sources, respecti- vely. The extracted polymer was characterized by Fourier transform infrared (FTIR), and UV-vis spectroscopy, which confirmed the structure of the polymer as PHB. The isolate can be considered an excellent candidate for industrial production of PHB from agricultural wastes.

Introduction:

Plastics made from petroleum are essential to daily living. Although the use of plastics cannot be completely eliminated, it is important to manage plastic trash to prevent harmful impacts on humans.

The addition of chemicals, dyes, and stabilisers to recycled plastics results in more environmental issues than with the original material. The bioplastic is an option due to environmental and waste management issues. A new generation of polymers with many applications that are either biobased, biodegradable, or have both of these qualities is known as bioplastic. It is a more environmentally friendly alter- native to plastics and biodegrades into CO_2, methane, H_2O, and biomass when exposed to microbial enzymes. Although the production of bioplastic will result in a reduction in the consumption of fossil fuels, CO_2 emissions, and the generation of plastic waste, the high cost of producing bioplastic from bacteria remains a significant barrier when compared to the cost of producing petroleum-derived polymers.

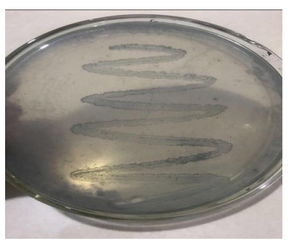
PHBs are macromolecules synthesized by bacteria and are inclusion bodies accumulated as reserve material when the bacteria grow under different stress conditions. However, a major problem for extensive production and commercialization of PHBs is their high produc- tion cost as compared with plastics derived from petrochemicals. Recently, much effort has been committed to reduce the production cost of PHB by using strategies such as; developing efficient bacterial strains, optimizing fermentation and recovery processes. Most reports regarding the production of PHB suggested that, the major contributor to the overall PHB production cost was carbon substrate cost. As such, the selection of efficient carbon substrate is a key aspect, which verifies the total cost of the final product. The alternative approach is to choose renewable, economically feasible and most readily available carbon substrates for both microbial growths and efficient PHB production. Therefore, the objective of the present study was to isolate PHB producing bacteria and study its PHB production from agricul- tural waste materials

METHODOLOGY

Conclusion:

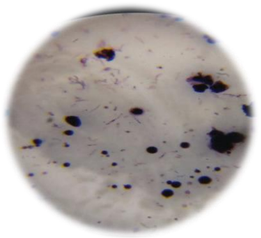
The results of this study confirmed that cheaply available agro-residues can be used for the production of PHB serving triple purposes of reducing the cost of biodegradable plastics, reducing environmental pollution problems caused by conventional plastics and solving disposal problem of the agricultural wastes.

Result:



SCREANING OF PHB PRODUCING BACTERIA:

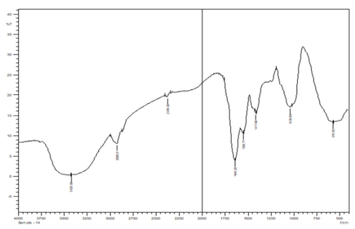
Isolated culture of PHB producing bacteria:



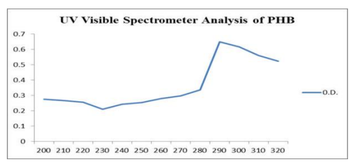
Photomicrograph of isolates showing the PHB granules produ- ced in form dark granules in the bacterial cells:

Effect of temperature, time and pH on production of Polyhydroxybutyrates (PHB) by isolate C4

PARAMETER	DRY BIOMASS (MG/DL)	PHB (MG/DL)
TEMPERATURE		
30°C	0.0135	0.0010
37°C	0.2855	0.0173
40°C	0.0528	0.0009
50°C	0.0757	0.0021
TIME		
18 HOURS	0.09	0.0007
24 HOURS	0.0284	0.0003
48 HOURS	0.1706	0.023
72 HOURS	0.1564	0.010
PH		
6.5	0.0426	0.0005
7	0.0924	0.0041
7.5	0.6626	0.0170
8	0.1296	0.0194



FTIR analysis of Polyhydroxybutyrates polymer extracted from isolate c4:



UV-Vis spectrophotometer analysis of PHB:

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Poster presentation (Department of biochemistry, Jinnah University for Women, Karachi - 74600)