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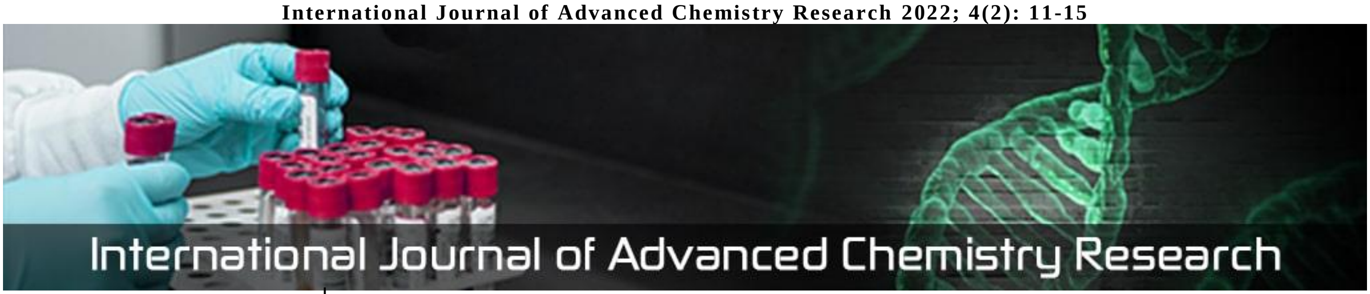

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Inzer Gul Afghan
Department of Chemistry, Education Faculty, Paktia University, Paktia, Afghanistan

Anupama Shrivastav
Department of Microbiology, Applied Science Faculty, Parul University, Gujarat, India

Ajmal Hashmi
Department of Chemistry, Education Faculty, Paktia University, Paktia, Afghanistan

Hazratuddin Sadiqi
Department of Chemistry, Education Faculty, Paktia University, Paktia, Afghanistan

Corresponding Author:
Inzer Gul Afghan
Department of Chemistry, Education Faculty, Paktia University, Paktia, Afghanistan

Medical importance, characteristics, environmental and economic value of bacterial Polyhydroxyalkanoates

Inzer Gul Afghan, Anupama Shrivastav, Ajmal Hashmi and Hazratuddin Sadiqi

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Abstract
Aims of this study denote the medical importance, characterization, ecological, and economical value of bacterial Polyhydroxyalkanoates and Polyhydroxybutyrate through various research study. Are now available for tissue engineering. Studies due to their biocompatibility and biodegradability properties, Biodegradable Plastics are new and very interesting Because of their actual utilization by microorganism. Biopolymer are natural raw material of bioplastic that are synthesized and catabolized by various microorganisms. And not cause toxic to the host bodies and environment. PHA production were isolated from various sources like, oil soaked, dairy effluent cloth and local food and hydrophobic waste. Reviews of this study based on medical importance, drug delivery, therapeutic uses, tissue repair, organ replacement, inexpensive and readily available carbon source and free different waste nutrient for organisms. Providing high productivities and inexpensive purification procedure. Finally, this review explores a wide prospect for PHA application due their clinical and great free different waste sources, biocompatibility properties in worldwide markets.

Keywords: Polyhydroxyalkanoates, microorganism, polyhydroxybutyrate, drug delivery

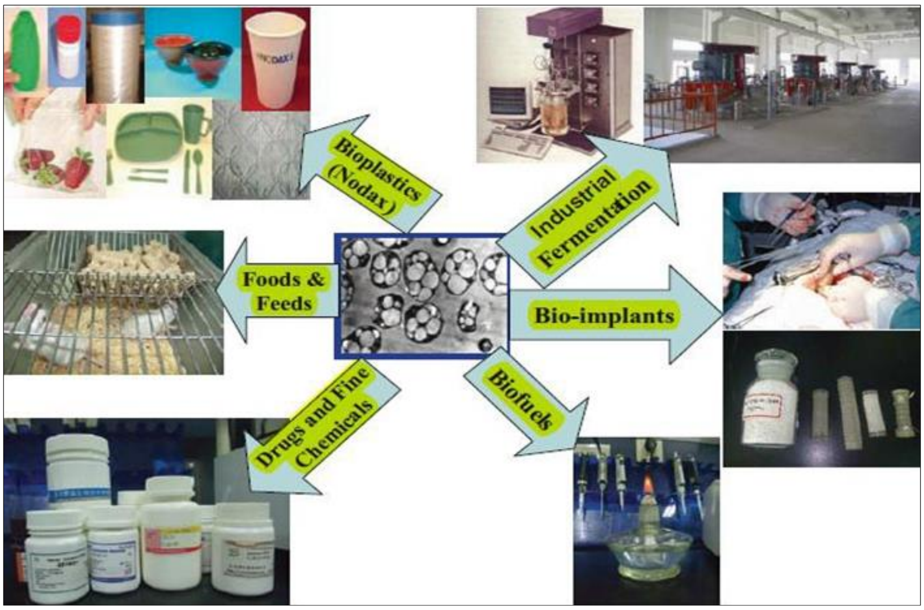
Introduction

History of Polyhydroxyalkanoates: The first example of Polyhydroxyalkanoates to be discovered was Polyhyroxybutyrates (PHB) in the year 1926 by Maruice Lemolgne. Beijerinck was the first person to denote this structure in 1888 he used the microscope to observe the granules, Chemical composition of PHA was determined in 1926 by the Maurice Lemoigne, he determined the capability of soil *bacterium*, *Bacillus megaterium* to breakdown the polymer under anaerobic condition into 3- hydroxybutyric acid (3HB) monomers.

Fig 1: Beijerinck was the first person to denote this structure in 1888

Application and properties

Biodegradable polymers of polyhydroxyalkanoates (PHAs) naturally obtained by different microorganism aggregate as energy store under abundant carbon, and limiting nitrogen sources, however, bacterial isolates form dairy sewage, local mess food, oil wastes, oil dipped cloth, and few type cultured in suitable mediums were screened for polyhydroxyalkanoates production, approximately bacterial isolated from oil dipped cloth have maximum concentration of polyhydroxyalkanoates production, and it was later recognize as (*Bacillus cereus*) by 16S rDNA analysis method.



Characterization and bioproduction of medium chain length Polyhydroxyalkanoates (mcl-PHAs synthesis by *Pseudomonas putida* Bet001 obtain from palm oil mill issuant was studded, however, bio production of medium chain length (mcl-PHAs) by 12 the *Pseudomonas putida* Bet001 follows a growth associated attitude, Accumulation of medium chain length (mcl-PHAs) ranging from 49.7 to 68.9% on cell dry weight (CDW) bases were observed when fatty acid ranging from octanoic acid (C8:0) to oleic acid (C18:1) were used as sole carbon and energy source. Estimation of molecular weight of polymer was found to be ranging from 55.7 to 77.7 k Da, depend on to usage of fatty acid, approximately two type of instrumentation 1H-NMR, GCMS, MS analysis the chiral atom chain polymer with monomer length of C4 to C14 with C8 and C10 as the principal monomers.

Table 1: Molar ratio of carbon to nitrogen effect on PHA content and biomass in culture of *P. Putida* Bet001

C: N (mole)	PHA (% w/w dried biomass)	Biomass (g L-1)	Mw (Da)	X p	PDI
10	16.2	9.60	49147	0.76	2.1
15	39.3	11.4	52143	0.74	2.1
20	55.5	15.3	74958	0.72	2.1
25	68.9	15.5	45678	0.75	2.1
30	68.4	13.9	37444	0.73	2.2

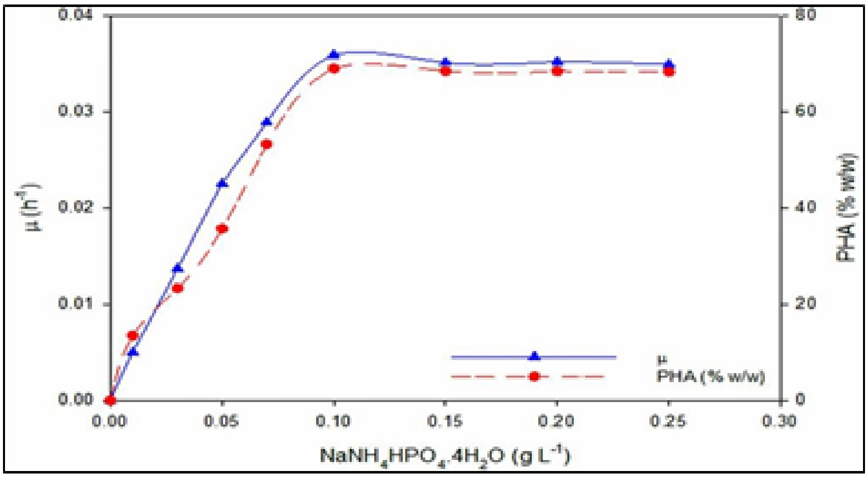


Fig 3: The following graph showed specific growth rate and (PHA) contents as a function of ammonium ion concentrations as content of PHA in *P. putida* Bet001.

Fig.3 Showed the medium chain length of bio monomer ranging from C4 to C10, no unsaturated monomer was detected, according to thermo chemical analysis showed the PHAs accumulation to be semi crystalline polymer with high thermal stability, degradation temperature (Td) ranging from 264.6 to 318.8 (±0.12)0C, melting temperature (Tm) 43. (±0.2)0C, glass transition temperature (Tg) of -1.0 (±0.2) oC, melting enthalpy of fusion (ΔHf) of 100.9 (±0.1) J g-1. (Ahmad Mohammed Gumel *et al*, 2012) [3].

Table 2: Different microorganism that produce PHA

S/N	Microenvironment	Fermentation method	Substrate	PHA content (%, DCW)
1	*Pseudomonas aeruginosa*	Batch	Activated sludge with nonanoic acid	48.6, YP/S 0.94 /g
2	Mixed microbial culture	2-stage CSTR	Sugar cane molasses	61
3	*Ralstonia pickettii*	Shake flask	Sugar cane molasses	50
4	*Pseudomonas fluorescens*	SMF, Batch	Sugarcane liquor, glutamate and salts	70
5	*Bacillus cereus M5*	SMF, Batch	Beet molasses	73.8
6	*Azotobacter vinelandii* UWD	SMF, Fed Batch	Beet molasses and valerate	59-71
7	*Bhurkolderia* sp. And *Cupriavidus necator* (formerly *R. eutropha*)	SMF, Fed Batch	Sucrose from sugarcane	65-70
8	Rec. *E. coli* (*C. necator* genes)	SMF, Fed Batch	Beet molasses + salts + trace metals	80
9	Aerobic and anoxic condition	Batch	Food waste and Acidogenic effluents	40
10	Anaerobic condition	Continuous, Batch	fermented volatile fatty acids	65
11	*Cupriavidus necator*	Fed Batch	Peptone, meat extract and NaCl	80

Table 3: effect of various temperature and PH on PHA production

Condition		Cell mass (g/l)	μ (x 10^{-2}) (h^{-1})	q_p (x 10^{-2}) (h^{-1})	$Y_{(P/X)}$	PHA content (%, DCW)	Time to achieve maximum production (h)
pH	6	2.0	1.46	5.64	3.86	32	60
	7	3.1	1.94	5.82	3.0	40	60
	8	2.8	1.96	4.62	2.36	33	48
Temperature (°C)	25	2.5	2.03	4.51	2.22	38	36
	30	3.1	1.94	5.19	2.67	39	60
	35	2.8	2.19	2.67	2.41	40	60

The specific growth rate of microorganism (μ). The maximum specific product formation rate (qp) and specific product yield [Y(P/X)] was observed at pH 7and 30 °C. (Ahmad Gholami *et al*, 2016) [2].

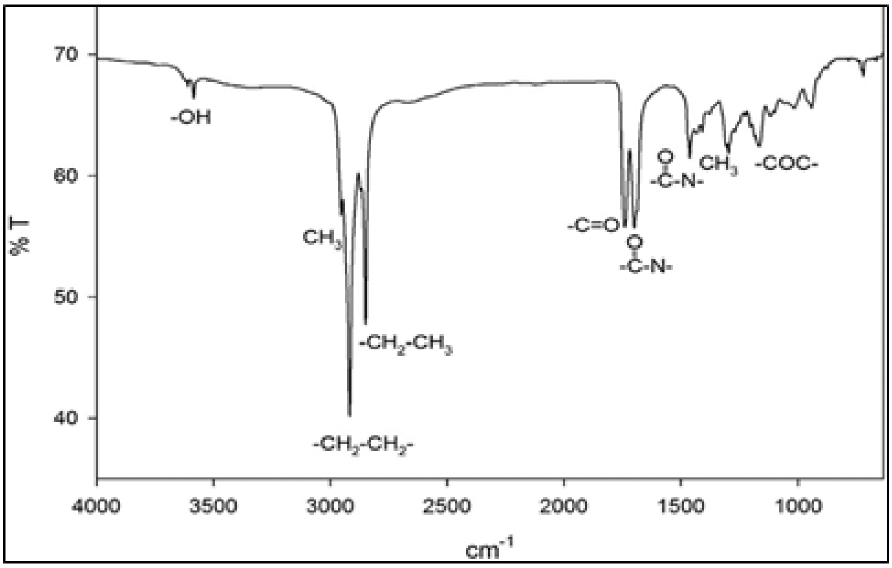


Fig 4: Identification of PHA by the analysis of FTIR-ATR spectrum usage of oleic acid from P. *putida* Bet001.

(Ahmad Mohammed Gumel *et al*, 2012) [3] Studies showed that the application of biodegradability and properties of polyhydroxyalkanoates (PHAs) at various industrial and biomedical utilizing due to their biodegradability, resorb ability, compatibility, and piezoelectricity, however study showed that several bacteria species accumulating PHA compound, these bacteria can be isolated from different industrial waste material, *Pseudomonas genus* of bacteria are famous to accumulate PHA in presence of carbon source and suitable medium, so these bacteria is fed to fatty acid it passes through the beta oxidation biosynthetic pathway, to synthesize PHAs, therewith losing two carbon atom per each cycle, different published word use unsaturated fatty acid such as oleic acid to produce mcl-PHAs with a side chain of unsaturated monomer of fatty acid.(Gumel *et al*., 2012) [3].

According to the polyester bonding density and specific hydrophobic characteristics at surface of polyester crystal and adsorption of enzyme on the surface of crystal depend to the amount of ester bond rather than the hydrophobicity of the surface, Similarly, binding of PHA depolymerase to the polyester part of aliphatic, not only hydrophobic interaction but also specific interaction between binding domain and poly ester bond. Degradation speed of PHA DE polymerase by the enzymatic reaction of P (3HB) is dependent to PHA crystalline condition, specially contain PHA reaction state, concentration and properties of DE polymerase enzyme, however, when the concentration of de polymerase enzyme get increased enzymatic hydrolysis reaction also get increase, Yamashita *et al* study showed that every molecule of PHA on the film of P (3HB) adsorbed irreversibly on the crystal surface. Finally divided in solution through the attack of de polymerase enzyme, (Yamashita *et al.*, 2003).

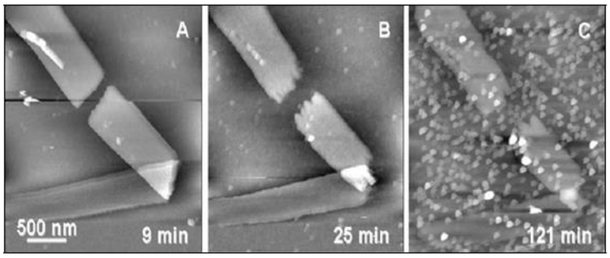


Fig 5: PHA adsorption and degradation on crystal surface by the PHA de polymerase enzyme

Study showed that PHA have two types of region amorphous and crystal, amorphous region of PHA was easily degradable compare to crystal region of PHA, identification of degradation rate determined by the degradation of crystal region of PHA, also identification of enzymatically degradation rate used the degrading of crystal region of PHA, depend to crystal size, crystal condition, crystallinity, crystal thickness, research also showed the lamellar crystal and various degradation mechanism of PHA.

Conclusion

Polyhydroxyalkanoates (PHAs) and Polyhydroxybutyrates are intracellular granules of microorganisms, A technology needs great attention to develop an integrated system of isolation of high-valued bacterial synthesized, these significantly important biologically produced bio-products demand severe confirmation of industrial process contributing as key element towards high-cost production, medical application of polymer with close to 100% purity is needed A study using PHB microspheres demonstrated that release of the anti-tumor drug rubomycin inhibited proliferative activity of Ehrlich's carcinoma in mice. the advent research on dual production of bio polymeric materials (extracellularly and intracellularly). And also, PHA drug delivery systems offer unique methods by which to control release. One can envision systems for delivery of growth factors or immunomodulators using PHA systems. PHA have grate medical applications medical field. PHA and PHB to have this high-valued exopolymers and endopolymers duel synthesized using the same microorganisms under suitable conditions utilizing biological wastes may help us to combat the issues' relevance to cost production, environmental pollutions and their commercialization into the market.

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