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# Development of Innovative Biotechnological Processes to Produce Bioplastics from Agrifood Supply Chain Waste using Selected Microorganisms

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## State-of-the-Art

The growing concern about the availability of natural resources and the need to reduce the environmental impact of waste plastics has prompted the search for eco-friendly plastic materials. Biopolymers, or organic plastics, offer the dual benefits of preserving fossil resources and reducing dioxide carbon emissions, making them an important development innovation sustainability (Bugnicourt *et al*., 2014). In this regard, the polyhydroxyalkanoates (PHAs) have attracted attention as a versatile and promising class of bioplastics (Mathuriya and Yakhmi, 2017). They are natural polymers, produced through the microbial fermentation of renewable carbon sources, such as sugars or plant oils, and stored as an energy reserve in the cytoplasm and inner membrane of these microorganisms in the form of granules between 0.2 and 0.5 µm in diameter (Raza *et al*., 2018). The synthesis of PHA occurs in the deficiency of essential nutrients (N, P, S) and excess of a carbon source.

## Objectives and Milestones

Based on the above considerations, the current research project, cofounded by the company Eggplants srl, aims to optimize the synthesis of PHA using agribusiness wastes as substrates for fermentation of selected microorganisms having high capacities to produce PHA. According to the Gantt diagram given in Table 1 the biotechnological process development will include the set-up of the different substrates and the selection of the most efficient growth conditions for each microbial starters: *Azohydromonas lata*, *Haloferax mediterranei*, *Cupriavidus necator*, genetically modified *Escherichia coli*. Subsequently, having evaluated the chemical characteristics of the extracted polymer, PHB production will be optimized on pilot plant and industrial scale. The ultimate goal will be to finalize the bioplastic production in a circular economy context for food packaging design.

**Downstream processing**

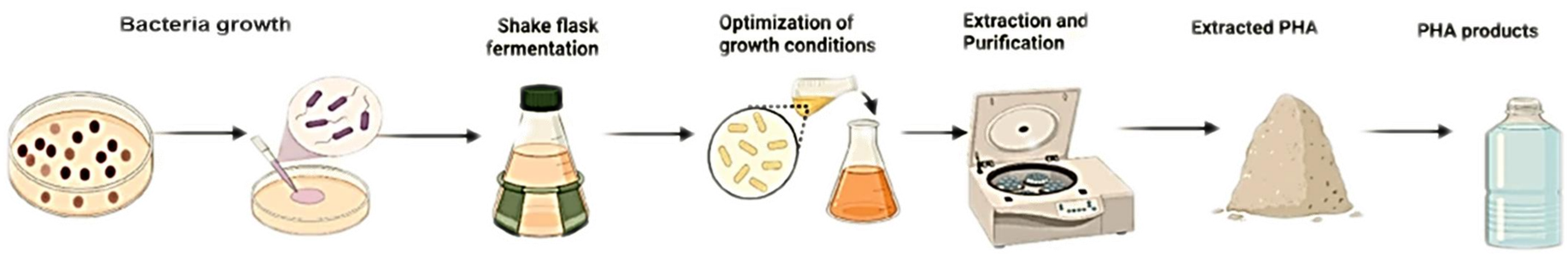


***Table 1***. Gantt diagram of PhD thesis project.

| Activity | Months | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
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| **A1)** | **Biotechnological process** | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1) Set-up of food-waste substrates | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2) Optimizing growth parameters | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3) Chemical characterization | | | | | | | | | | | | | | | | | | | | | | | | |
| | 4) Set-up of ”green" downstream process | | | | | | | | | | | | | | | | | | | | | | | | |
| **A2)** | **Scaling-up** | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1) Pilot scale | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2) Industrial scale | | | | | | | | | | | | | | | | | | | | | | | | |
| **A3)** | **Food packaging** | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1) Eco-packaging design | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2) Active packaging optimization | | | | | | | | | | | | | | | | | | | | | | | | |
| **A4)** | **Thesis and Paper Preparation** | | | | | | | | | | | | | | | | | | | | | | | | |

## Selected References

Bugnicourt *et al*. (2014). Express Polymer Letters, Vol.8, No.11 (2014) 791–808.
Raza *et al*. (2018). International Biodeterioration & Biodegradation. Vol. 126, 45-56.
Mathuriya and JYakhmi (2017). Handbook of Ecomaterials.

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