Biocatalysis in the synthesis of valuable substances from cyanobacterial cells

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Microbial biotransformation can be considered as a mechanism by which a compound (substrate) is transformed (by means of microbial enzymes known as biocatalysts) into a desired substance(s) with ecofriendly, economic, and financial importance. In this research, cultures of several strains of cyanobacterial whole cells (*Synechococcus bigranulatus*, *Nostoc cf-muscorum*, *Kamptonema animale*, *Limnospira maxima*, *Limnospira indica*, and *Leptolyngbya foveolarum*) were selected as biocatalysts due to their robust catalytic mechanisms [1]. The productive potential of cyanobacterial strains to catalyze organic redox reactions and/or enzymatic hydrolysis of the target substrates in this research, phosphonates (vinyl and epoxy phosphonates) and 1-phenylethyl acetate and transforming them into valuable substances (Figure 1 b and c) has remained largely unexplored because of their unyielding and competitive inhibitors to several biocatalysts [2,3]. Biocatalysis of phosphonic compounds and 1-phenylethyl acetate has the potential for the synthesis of optically pure compounds that could present a platform for further applications in agrochemicals, flavors, cosmetic and pharmaceutical industries [4]. The current research could also be targeted at resolving the challenges of chemical synthetic approach resulting in significant emission of harmful substances and pollution of the ecosystem. Cyanobacterial biocatalytic approach on the other hand, presents a safe, limited pollution and toxicity.

Bioconversion methods employed were as follows: a) preparation of a 21-days cyanobacterial cultures (for phosphonates substrates) in a growth chamber, and 7/14-days cultures (for 1-phenylethyl acetate substrate) in phytotron growth chamber; b) Biocatalytic reactions between substrates and microbial cultures under sterile and favourable growth conditions; c) centrifugation for biomass removal; d) extraction; e) monitoring of results via Liquid Chromatography with Mass Spectrometry detector (LC/MS); Nuclear Magnetic Resonance (NMR) of isotopes ^{1}H and ^{31}P; Infrared Spectroscopy (IR); and Gas Chromatography (GC) (for 1-phenylethyl acetate bioconversion).

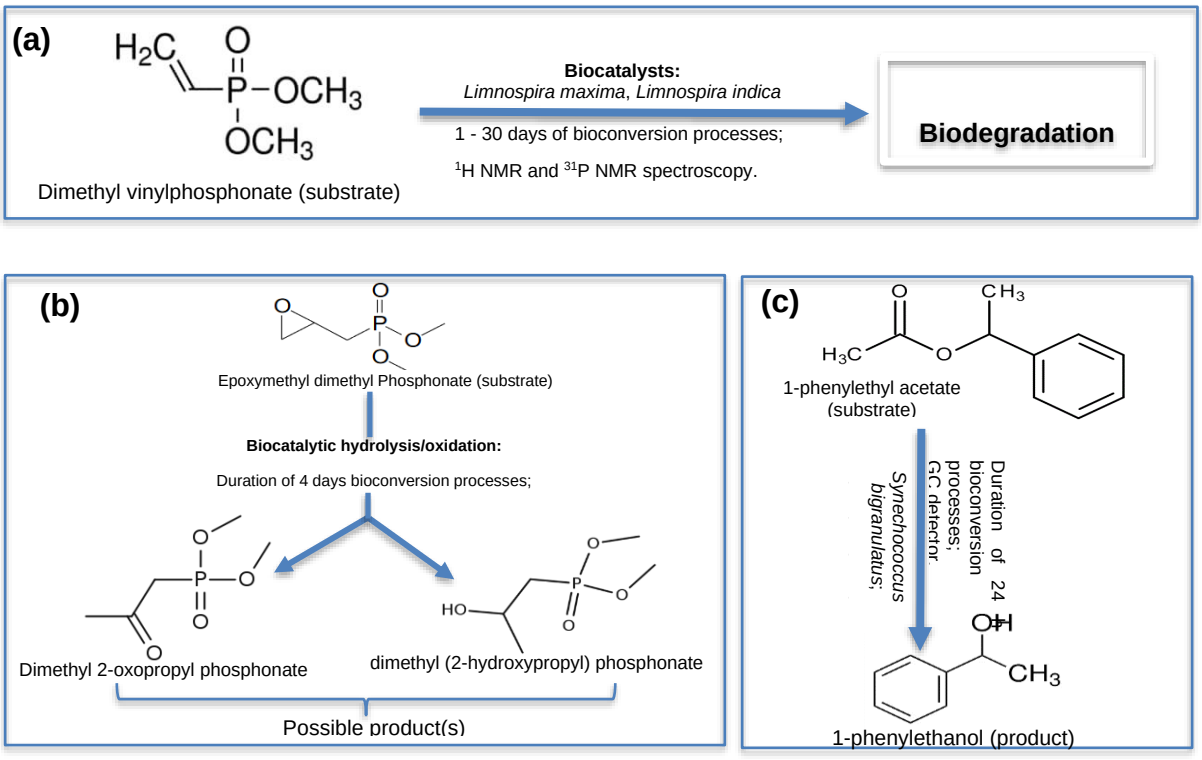

Figure 1. Possible sequences of photobiocatalytic reactions (a, b, and c).

Possible biocatalytic product, 1-phenylethanol (Figure 1c) is a secondary alcohol with increasing high demand in industries such as fine chemical, flavours, agrochemicals and pharmaceutical industries [3]. Dimethyl (2-oxopropyl)phosphonate (Figure 1b) has been explored as a reagent for the homologation of aldehydes to alkynes, which is a valuable transformation in organic synthesis [5]. Biodegradation observed in the case of vinyl phosphonate biotransformation process (Figure 1a) demonstrated the potentials of selected cells to degrade some phosphonates and using them as nutrient source. This finding could be ecologically important in limiting or eliminating pollution and toxicity of vinyl phosphonates or other similar undesirable phosphonic compounds in the environment.

References

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