Impact of redox stress on the growth of Rhodospirillum rubrum S1H

Paloma Cabecas Segura, Chiara Magnani, Anne-Lise Hansson, Audrey Tanghe, Florence Allert, Jean-Marie Raquez, Ruddy Wattiez, Baptiste Leroy

1. Department of Proteomics and Microbiology, Research Institute for Biosciences, University of Mons, Mons, Belgium
2. Department of Polymeric and Composite, Research Institute for Materials Science and Engineering, University of Mons, Mons, Belgium
3. Department of Chemical and Biochemical Engineering, Research Institute for Biosciences, University of Mons, Mons, Belgium
4. Materna Nova, Pure Initiates, Mons, Belgium

Introduction

Rhodospirillum rubrum is an α-proteobacteria that is known for its great metabolic versatility. Purple non-sulfur bacteria are well-studied for their ability to grow under photoheterotrophic conditions using energy from light and various volatile fatty acids (VFAs) as carbon and electron sources. Our previous studies revealed a production of polyhydroxyalkanoates (PHAs) when different VFA are used as carbon sources (Figure 1). PHAs are bio-sourced, biodegradable polymers that could be used to replace traditional oil-based plastics.

When growing on acetate, Rhodospirillum rubrum is known to present a characteristic long lag phase, which is hypothesized to be due to redox unbalance in the cell. In the lab acetate competent cells, strain of Rhodospirillum rubrum presenting an amplification of a gene fragment containing the coding sequence of the EM, such as the cytochrome reductase/carboxylase, have been obtained.

For Rhodospirillum rubrum S1H, there is no lag phase when bicarbonate are present in excess. This is not the case for the acetate competent strain, that presents this growth phenotype whatever the concentration of bicarbonate. Indeed when grows on other reduced substrates such as butyrate, the growth is still dependent of bicarbonate supplementation.

The gene amplification and over expression give advantage to the strain only when acetate is used as carbon source.

When used as sole carbon source, propionate and butyrate required a large amount of bicarbonate to be completely assimilated but when used as a blend only a small amount of bicarbonate is needed. When used as a blend, VFA are sequentially assimilated.

Table 1: Ratio between carbonate consumption and propionate and butyrate assimilation when used as sole carbon source or as a blend

<table>
<thead>
<tr>
<th>Carbon sources</th>
<th>Carbonate/Biomasse (mM/mM)</th>
<th>Propionate</th>
<th>Butyrate</th>
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<tbody>
<tr>
<td>Mix</td>
<td>1.74</td>
<td>0.3</td>
<td>0.21</td>
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Conclusion

Redox balance is one of the major parameter of photoheterotrophic growth on reduced substrate such as VFA. It seems that it could impact the production of biomass, by inhibiting the growth or leading to a long lag phase. Increasing the flux in the EM pathway, by gene amplification or bicarbonate excess in the medium seems to be a mechanism to deal with this unbalance. Blend of VFA also seems to impact the redox stress of the cell. Further investigations are needed to better understand this phenomenon and its impact on PHA synthesis.

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References