Phycocyanobilin (PCB) is a linear tetrapyrrole chromophore covalently attached to protein subunits of phycobiliproteins, C-Phycocyanin (C-PC) and Allophycocyanin (APC), present in the light harvesting complexes of the blue-green algae *Arthrospira platensis*. PCB absorbs light in the red region of the electromagnetic spectrum, thereby exhibiting a vivid blue color. Therefore, it has great significance to the food industry due to its potential as a natural blue food color. The chemical synthesis of PCB is very complex and economically not feasible. Hence, there is a demand for the development of process to obtain PCB from phycobiliproteins. PCB is attached to the protein subunits through a cysteine residue with a thioether linkage. In this work, the kinetics of the cleavage process of PCB from protein subunits by methanolysis is investigated.

### INTRODUCTION

Although the model explains kinetic observations well, a two step model might be an over simplification.

### KINETIC MODEL FOR CLEAVAGE OF PCB BY METHANOLYSIS

Cleavage of PCB can be described either as two first order reactions in parallel:

\[
P - v_1 \text{PCB(I)} \rightarrow P + v_2 \text{PCB(II)}; \quad P - v_2 \text{PCB(II)} \rightarrow P + v_2 \text{PCB}
\]

Or two first order reactions in series:

\[
P - v_1 \text{PCB(I)} - v_2 \text{PCB(II)} \rightarrow P - v_2 \text{PCB(II)} + v_1 \text{PCB(I)}; \quad P - v_2 \text{PCB(II)} \rightarrow P + v_2 \text{PCB}
\]

Where PCB(I) is easily accessible and PCB(II) is less accessible for cleavage, \(v_1\) and \(v_2\) are stoichiometric coefficients of PCB(I) and PCB(II), respectively. In a batch reactor the reactions in parallel will appear as a single first order reaction and can be represented by following set of equations:

\[
\begin{align*}
\frac{dC_1}{dt} &= -k_1 \cdot C_1; \\
\frac{dC_2}{dt} &= k_1 \cdot C_1 - k_2 \cdot C_2
\end{align*}
\]

Analytical solutions for set of equations above is:

\[
C_1(t) = C_{10} \cdot e^{-k_1 \cdot t}; \quad C_2(t) = \frac{k_1 \cdot C_{10}}{k_1 - k_2} \left(e^{-k_1 \cdot t} - e^{-k_2 \cdot t}\right) + C_{20} \cdot e^{-k_2 \cdot t}
\]

Where \(C_{10}\) and \(C_{20}\) are initial concentration of PCB(I) and PCB(II), respectively.

Based on stoichiometry of reaction, the concentration of PCB can be expressed as:

\[
C_{\text{PCB}}(t) = v_1 \cdot C_{10} \cdot \left(1 + \frac{v_2}{v_1} \cdot \frac{C_{20}}{C_{10}}\right) - v_1 \cdot C_{10} \cdot \left(1 + \frac{v_2}{v_1} \cdot \frac{C_{20}}{C_{10}}\right) \cdot e^{-k_1 \cdot t} + v_1 \cdot C_{10} \cdot \left(\frac{C_{20}}{C_{10}}\right) \cdot e^{-k_2 \cdot t}
\]

### EXPERIMENTAL

- **Linabluex (Commercial extract of *Arthrospira platensis*)** boiled in 400 mL methanol for 16 h at 65 °C
- Mixture samples are taken at regular interval for HPLC analysis
- Three different initial concentration of Linabluex used

### RESULTS

**Table 1. Model data fitted to experimental data.**

<table>
<thead>
<tr>
<th>Initial protein concentration (mg/mL)</th>
<th>(v_1)</th>
<th>(C_{10})</th>
<th>(v_2)</th>
<th>(C_{20})</th>
<th>(k_1) (h(^{-1}))</th>
<th>(k_2) (h(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2.7 \times 10^{-3}</td>
<td>24</td>
<td>1.0 \times 10^{-4}</td>
<td>33</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>4.7 \times 10^{-3}</td>
<td>25</td>
<td>12 \times 10^{-3}</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cleavage of PCB as a function of time. Fully drawn lines are calculated using the model with the parameters from Table 1.

### CONCLUSION

- Kinetic model describes the experimental data adequately
- The ratio between \(v_2\) and \(v_1\) is too large compared to the prior findings where a ratio 0.2 and 0.3 is more likely if all PCB is cleaved
- Although the model explains kinetic observations well, a two step model might be an over simplification

### ACKNOWLEDGEMENT

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