The Effect of Prokaryotic Translation Initiation Factor Overexpression on Escherichia coli Growth Under Temperature-Induced Stress

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Translation initiation is a major control point in bacterial gene expression, yet how initiation factors affect population level growth remains poorly quantified, specifically under environmental stress. This study overexpressed the prokaryotic initiation factors IF1, IF2, and IF3 in Escherichia coli and recorded growth at 20°C, 37°C, and 42°C. Logistic models were fit to growth curves to estimate carrying capacity, intrinsic growth rate, and inflection time, with residual sum of squares used to assess goodness of fit. Two way ANOVA on fitted parameters, followed by Tukey's HSD post hoc tests, revealed statistically significant effects of initiation factors and temperature on growth parameters. IF1 overexpression significantly increased carrying capacity at 37°C and 42°C relative to the control, while IF2 and IF3 produced smaller but consistent, significant increases. These effects align with the known roles of IF2 in initiator tRNA recruitment and IF3 in start codon selection and ribosomal recycling. IF1's superior performance suggests it may be limiting during stress or provide a more potent benefit when overexpressed. Across conditions, IF1, IF2, and IF3 overexpressing strains all showed significantly longer lag phases than the control, consistent with a measurable metabolic burden of initiation factor overproduction. However, intrinsic growth rate estimates did not differ significantly between strains under the current design. These results motivate future work that employs higher temporal resolution and integrates ribosome profiling to dissect mechanistic underpinnings with greater clarity.

Awards Won:

Zydus Pharmaceuticals USA Inc.: Third Place Cellular and Molecular Biology