Deciphering the Modulatory Role of RNA-binding Proteins in mRNA Stability Under Oxidative Stress Conditions

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Abstract. Oxidative stress is a significant factor affecting mRNA stability, ultimately influencing gene expression and cellular responses. This study investigates the role of RNA-binding proteins (RBPs) in regulating mRNA stability under oxidative stress, utilizing a combination of RNA-sequencing and biochemical assays. Our findings reveal a distinct set of RBPs that predominantly interact with mRNAs under oxidative conditions, facilitating their degradation or stabilization. Notably, we characterize the mechanisms by which specific RBPs modulate the stability of mRNAs encoding stress response proteins. These insights contribute to a deeper understanding of post-transcriptional regulation in response to oxidative stress, highlighting potential therapeutic targets for conditions exacerbated by oxidative damage. Our research underscores the critical interplay between RBPs and mRNA dynamics, paving the way for advances in molecular therapies aimed at enhancing cellular resilience against oxidative stress.

Keywords: mRNA stability, oxidative stress, RNA-binding proteins, gene expression regulation, post-transcriptional control, reactive oxygen species, molecular therapies

Introduction

The rise in oxidative stress-related pathologies underscores the growing need to understand the molecular mechanisms governing gene expression. Oxidative stress, characterized by an imbalance between reactive oxygen species (ROS) production and antioxidant defenses, has been implicated in various diseases, including cancer, neurodegenerative disorders, and cardiovascular diseases. In eukaryotic cells, mRNA stability is a crucial determinant of gene expression and can significantly influence cellular responses to oxidative challenges. Recent studies have identified RNA-binding proteins (RBPs) as pivotal players in the regulation of mRNA stability, acting through diverse mechanisms such as binding to

specific mRNA sequences or involving interactions with other regulatory proteins. While oxidative stress is known to affect the functionality and expression levels of RBPs, the specific relationships between RBPs and mRNA stability during such conditions remain largely unexplored. In this study, we aim to elucidate the role of RBPs in modulating the stability of target mRNAs under oxidative stress conditions. We employ RNA-sequencing to identify changes in mRNA expression profiles after oxidative exposure and biochemical assays to confirm the involvement of selected RBPs. Our research seeks not only to contribute to the understanding of post-transcriptional regulation in stress response pathways but also to uncover potential therapeutic targets for enhancing cellular resilience against oxidative stress-induced damage. The subsequent sections of this paper will detail our experimental design, present our findings regarding RBPs and mRNA interactions, and discuss the implications of our results in the context of oxidative stress-related diseases.

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