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The study of salt concentration effect on α-synuclein fibril structure in the presence of an electric field

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Abstract

Aggregation of the intrinsically disordered protein α-synuclein is the primary cause of Parkinson's disease and related neurodegenerative disorders. Multiple studies have shown that electric fields at various voltages have significant effects on the secondary structure of proteins. Moreover, the influence of salt concentration is crucial in the aggregation process of α-synuclein. In this study, we conducted two all-atom molecular dynamics simulations for 60 nanoseconds on α-synuclein fibrils to elucidate the structural features of protein fibrils under the influence of an electric field (0.4 V/nm) and a low salt concentration (50 mM). We prepared two systems under the effect of an electric field and introduced salt concentration to one of them. This comprehensive approach provided valuable insights into the role of salt concentration and electric fields in shaping the structure of α-synuclein fibrils. The results indicate that the number of hydrogen bonds decreases under the influence of an electric field, suggesting instability of the beta structures, which are crucial for fibril consistency. Additionally, the number of helices and coils increases. Nevertheless, the ratio of helix to coil under the combined effect of salt and an electric field is higher than that observed without the application of salt concentration. Overall, this study has the potential to enhance our understanding of the molecular mechanisms underlying neurodegenerative diseases and may contribute to the development of novel therapeutic strategies targeting α-synuclein fibrils.

Key words: Electric field; Salt concentration; α-Synuclein; Aggregation, Parkinson’s disease