Additionally, H_2O_2 treated plants showed superior chlorophyll retention, which supports greater photosynthetic efficiency. Salinity often degrades chlorophyll and impairs light-harvesting complexes, reducing carbon fixation and energy production. By preserving chlorophyll, H_2O_2 indirectly bolsters carbohydrate synthesis and translocation, ultimately contributing to improved grain quality. This pattern mirrors findings in maize and pea subjected to salt stress, where maintained photosynthetic pigments enhance overall plant performance (Zahra et al., 2022; Stefanov et al., 2024).

Overall, this investigation addresses an important knowledge gap regarding maize specific applications of H_2O_2 under salinity, drawing parallels to how other modulators like salicylic acid have been used successfully in different crops (Elsisi et al., 2024). The findings position H_2O_2 as a promising, sustainable tool for boosting maize resilience in saline prone agricultural areas, where soil salinization is increasingly driven by climate change, poor irrigation practices, and other factors (Singh, 2022). That said, the incomplete protection at very high salinity levels underscores the need for additional studies to fine tune H_2O_2 concentrations, application timing (e.g., priming versus foliar sprays), and methods to achieve optimal results under severe conditions. Such optimization could further enhance its practical utility in saline agriculture.

5 Conclusion and Recommendations

In conclusion, these screenhouse-based results indicate that hydrogen peroxide shows promise as a signaling molecule capable of partially alleviating salinity stress effects on maize, potentially contributing to improved resilience in saline environments and supporting food security in affected areas (as highlighted in global assessments of salt-affected soils). However, the evidence remains preliminary and context-specific to controlled conditions.

The study demonstrates that salinity stress markedly impairs *Zea mays* (maize) growth, yield, grain nutritional quality, and leaf chlorophyll content, with the strongest negative impacts observed at 250 mM NaCl. Key parameters such as plant height, leaf production, stem girth, root development, biomass accumulation, grain number (declining from 226.25 to 84.50 per plant at 250 mM NaCl without mitigation), and grain proximate composition (e.g., protein decreasing from 15.14% to 13.44%, fat from 1.88% to 1.74%, crude fiber from 3.40% to 2.74%) were progressively reduced, consistent with effects of osmotic stress and ion toxicity. Chlorophyll content also declined, likely due to chloroplast damage affecting photosynthetic capacity.

Based on this research the application of hydrogen peroxide (H_2O_2) consistently alleviated these adverse effects across the tested salinity levels (50~250 mM NaCl). Treated plants showed improvements, including greater plant height (123.52 cm vs. 112.19 cm at 250 mM NaCl), higher biomass (approximately 10%~15% increase), increased grain number (88.12 vs. 84.50 per plant), enhanced grain quality (e.g., protein at 14.31%, fat at 2.41%, crude fiber at 2.80%), and better maintenance of chlorophyll content, which may support improved photosynthetic efficiency. These observations align with prior research indicating that exogenous H_2O_2, often applied as a priming or foliar treatment, can enhance antioxidant defenses, protect chloroplast ultrastructure, modulate metabolites, and improve physiological performance under salt stress in maize. Nonetheless, H_2O_2 mitigation did not completely restore parameters to non-stressed control levels, especially under severe salinity (250 mM NaCl), suggesting inherent limitations in extreme conditions.

Field validation under natural saline soils, along with further exploration of optimal application methods, concentrations, physiological/biochemical mechanisms (e.g., antioxidant enzyme responses, ionic homeostasis), and possible integration with other amendments or interventions, would be essential to strengthen any practical recommendations for maize production in salt-affected regions.

Author's contribution

O. Kekere was the experimental designer, and J. K. Afolabi was executor of the study; J. K. Afolabi completed data analysis and wrote the first draft of the paper; J. K. Afolabi participated in the experimental design and analysis of experimental results; O. Kekere was the project conceptualizer and leader, guiding experimental design, data analysis, paper writing and revision. The paper was read and received the approval of both authors for publication in the journal.