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Artificial intelligence and machine learning in postharvest fruit quality assessment: Current challenges, recent advances, and future prospects

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Abstract

The postharvest phase is critical to maintaining the quality, safety, and marketability of horticultural produce. Artificial Intelligence (AI) and Machine Learning (ML) have emerged as transformative tools in this domain, offering rapid, non-destructive, and highly accurate methods for assessing fruit quality. This review provides a comprehensive and critical analysis of the current state of AI and ML applications in postharvest quality assessment, with an emphasis on recent advancements in deep learning, computer vision, and predictive modelling. Despite significant progress, notable challenges persist including limited model generalizability across fruit types and environments, the high cost of implementation, data scarcity, and a lack of standardized protocols. These issues are particularly acute for smallholder farmers and low-resource settings. This review identifies critical research gaps such as the need for scalable, interpretable, and low-cost AI solutions, robust models capable of

operating under dynamic environmental conditions, and interdisciplinary collaboration for practical deployment. It highlights novel approaches, including lightweight AI for edge computing, multi-modal sensor integration, and the use of open-source platforms to enhance accessibility. By synthesizing existing knowledge and mapping out future research directions, this review offers a roadmap for the development of inclusive, efficient, and sustainable AI-driven postharvest systems.
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Author keywords

Artificial intelligence; Deep learning; Fruit quality; Machine learning; Postharvest technology

Indexed keywords

Engineering controlled terms

Fruits; Learning systems; Quality control

Engineering uncontrolled terms

'current; Artificial intelligence learning; Deep learning; Fruit quality; Future prospects; Machine-learning; Postharvest; Postharvest technologies; Quality assessment; Quality safety

Engineering main heading

Deep learning

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