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(57) Abstract :
The present invention provides an integrated chemical and device-based system for long-term, room-temperature stabilization of genomic DNA from crude biological samples including saliva, buccal cells, microbial swabs, blood lysates, and plant or animal tissues. The system comprises a Natural Deep Eutectic Solvent (NADES)–based vitrification formulation including sugars, polyols, amino-acid-derived components, polymeric and polysaccharide vitrification enhancers, chelating agents, antioxidants, antimicrobial stabilizers, and controlled water content, configured to rapidly reduce water activity, inactivate endogenous nucleases, chelate metal ions, and suppress oxidative and hydrolytic degradation. Upon controlled dehydration, the formulation forms a stable, high glass-transition temperature vitrified matrix that preserves high-molecular-weight DNA without refrigeration. The invention further provides a humidity-buffered sample-collection and storage device incorporating a one-way moisture-release mechanism and internal humidity-regulating elements to enable controlled drying while preventing moisture ingress during storage, including under tropical conditions. Preserved DNA remains compatible with PCR, qPCR, digital PCR, next-generation sequencing, and long-read sequencing platforms, enabling cold-chain-independent, field-deployable genomic preservation.

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