

## **Portable beef-freshness detection platform based on colorimetric sensor array technology and bionic algorithms for total volatile basic nitrogen (TVB-N) determination**

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Colorimetric sensor array (CSA) and bionic algorithms were integrated to form a facile platform for total volatile basic nitrogen (TVB-N) determination. First, a CSA containing twelve color-sensitive materials was prepared to obtain scent information of beef and generate scent fingerprints for visualization. Second, four bionic optimization algorithms, ant colony optimization (ACO), particle swarm optimization (PSO), simulated annealing (SA), and whale optimization algorithm (WOA), were used to extract the characteristic fingerprint variables from the CSA. Finally, the back-propagation neural network (BPNN) model combined with characteristic color components was constructed to determine the TVB-N during beef storage, with improved precision, robustness, and generalization performance. The results demonstrated that WOA had the best optimization performance, followed PSO, ACO, and SA. The BPNN model could realize high-precision quantitative determination of TVB-N during beef storage, as well as save resources for CSA preparation. Therefore, CSA in combination with an excellent bionic algorithm is expected to be a facile on-site sensing platform for monitoring food freshness.