Portable tool plus Smartphone technology for fast cocoa bean quality examination
Original title: Rapid differentiation of Ghana cocoa beans by FT-NIR spectroscopy coupled with multivariate classification

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Abstract: Ensuring the quality and traceability of cocoa beans is vital for the chocolate industry. This study explores the use of Near Infrared Spectroscopy (NIRS) combined with advanced classification techniques to differentiate Ghanaian cocoa beans based on their geographical origin. A dataset comprising 194 cocoa bean samples from seven cocoa-growing regions was analyzed. Principal Component Analysis (PCA) was employed to extract relevant information, revealing distinct cluster trends in the spectral data. Four multivariate classification methods – Linear Discriminant Analysis (LDA), K-nearest Neighbors (KNN), Back Propagation Artificial Neural Network (BPANN), and Support Vector Machine (SVM) – were evaluated and compared for their performance. Model performance was optimized through cross-validation. Results demonstrated that the SVM model outperformed other methods, achieving a 100% discrimination rate in both training and prediction sets after preprocessing with Mean Centering (MC). BPANN exhibited a discrimination rate of 99.23% for the training set and 96.88% for the prediction set, while LDA achieved rates of 96.15% and 90.63%, respectively. The KNN model achieved 75.01% accuracy for the training set and 72.31% for the prediction set. Non-linear classification methods outperformed linear ones. Overall, the study highlights the effectiveness of NIR Spectroscopy coupled with SVM in accurately discriminating cocoa beans based on their geographical origins, offering a reliable approach for quality assurance in the cocoa supply chain.

Gap addressed: This research addresses the need for rapid and accurate methods to differentiate cocoa beans based on geographical origin, addressing a gap in quality control and traceability management in the cocoa industry.

Sector/Industry focus: Stakeholders in the cocoa and chocolate industry, including cocoa farmers, processors, manufacturers, and retailers, would find value in this research. Additionally, certification bodies and regulatory agencies concerned with food safety and quality standards could benefit from the findings.

Potential uptake or practical application: Portable tool plus Smartphone technology for fast cocoa bean quality examination offers the best technique for quick and onsite measurement of cocoa bean quality attributes (fermentation index, pH, fat content, insect damage, slaty beans, classification of cocoa bean grade, acidity, polyphenols etc at Farmgate. This technology can be used by all stakeholders in the cocoa bean value chain with little or no training and further offers affordable and climate-friendly determination techniques without compromising efficiency, speed and accuracy. Thus this enables reliability of producer quality and safety.

Key recommendations: The combination of portable tools and smartphone technology for cocoa bean quality examination would transform the industry by making quality assessment

faster, more accessible, and more reliable. This innovation promotes sustainable agricultural practices. Hence, Cocoa bean value chain players and Industry practitioners are encouraged to adopt portable NIR Spectroscopic tool coupled with smartphone technology for cocoa bean quality control and traceability. Further research could focus on expanding the dataset to include cocoa beans from other regions and optimizing classification models for broader applicability. Collaboration between researchers, cocoa industry stakeholders, and technology providers would be essential to facilitate the integration of advanced spectroscopic techniques into cocoa production and supply chain management practices.

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