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Hyperspectral Imaging and Chemometrics for Colour and Nutrients Determination During Hot Air Drying of Cocoyam

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Abstract

Cocoyam is a root crop grown in the tropical and subtropical regions of the world for food. The crop is valued for its starchy corm and micronutrient composition of minerals, vitamins and bioactive compounds. Hot air drying of the starchy corm is commonly practised for preservation and value addition. However, hot air drying substantially changes the colour and nutrient composition of food materials. Therefore, adequate process monitoring and dynamic adjustment of the drying process are critical to avoid degradation of material properties and the loss in final product quality. In this study, hyperspectral imaging (HSI) and chemometrics were successfully applied to develop models for online monitoring of colour and chemical attributes during hot air drying of purple-speckled Cocoyam. Drying experiments were undertaken with purple-speckled Cocoyam slices of 4 mm thickness. The slices were dried in a cabinet dryer at a temperature of 60 °C until a final moisture content of 0.11 $^{kgW}/_{kgDM}$. Hyperspectral images were acquired during drying using a camera system operating in the spectral range 400 – 1700 nm. Samples were drawn during the drying process every 30 minutes for measurement of colour and chemical content using standard laboratory techniques. The colour attributes measured included CIELAB L*, a* and b*, browning index (BI), whiteness index (WI), chroma (C*) and hue angle (h°) while chemical attributes included total phenolic content (TPC), total flavonoid content (TFC) and the total antioxidant activity (TAA). The acquired HSI images were processed to derive spectral absorbance and reflectance. The spectral data were then split into calibration and validation datasets and pre-processed by taking the first and second derivatives. Prediction models were built using PLS regression and significant wavelengths were selected based on the regression coefficients. The performance of the PLSR models was assessed using the Root Mean Square Error (RMSE), coefficient of determination (r^2) and Residual Prediction Deviation (RPD). The agreement between predictions and observations was assessed using Huber regression and Bland-Altman analysis. The measures of performance and agreement applied revealed good comparability of prediction results to the observations on BI, b*, C*, h°, TFC and TAA collected using standard laboratory measurements.

Keywords: Antioxidant activity, colour, drying, flavonoids, food quality, method comparison, non-destructive assessment, phenolics

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