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Prediction of quality attributes and ripeness classification of bananas using optical properties

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ABSTRACT

Consumers consider the ripeness of fruit as a very important factor in making a choice at the time of purchase. Ripeness in fruit generally affects the eating quality and market price of fruit. This study investigated the potential of using the optical properties of banana such as absorption, reduced scattering and effective attenuation coefficients extracted from backscattered images captured at five different wavelengths of 532, 660, 785, 830, and 1060 nm for predicting the quality attributes of the fruits. It was observed that there was a very strong correlation between the optical properties investigated and the banana ripening stages at wavelengths 532, 660 and 785 nm. Absorption and effective attenuation coefficients showed a negative correlation with ripening stages while the reduced scattering coefficient exhibited a positive correlation with ripening stages. Prediction and classification models were developed using an artificial neural network to build both prediction and classification models. The visible wavelength region of 532, 660 and 785 nm gave the highest correlation coefficient (R) range of 0.9768–0.9807 for chlorophyll prediction and 0.9553–0.9759 for elasticity prediction, while the near infrared region of 830 and 1060 nm gave an R range of 0.9640–0.9801 for prediction of the soluble solids content (SSC) when the absorption and reduced scattering coefficients were used. For the classification of banana into ripening stages 2–7, the visible wavelength region gave the highest classification accuracy of 97.53%. This study has shown that the optical properties of banana can be employed for non-destructive prediction and classification of banana into different ripening stages.

1. Introduction

Bananas are naturally framed elliptical fruits with a firm, creamy flesh pulp encased in an inedible peel. It is one of the most consumed fruits in the world (Sampson et al., 2014). Among the world food crops, bananas are rated fourth. The fruit is rich in potassium, vitamins C and B6, fibre, tryptophan and amino acid (Sampson et al., 2014; Sheehy and Sharma, 2011). Ripeness is one of the determining factors in postharvest handling and processing of fruit generally. It determines the consumer's acceptability and the eating quality. Bananas are usually harvested when fully mature but not yet ripe so as to allow for postharvest handling and transportation (Thompson and Burden, 1995). Based on the final utilisation of the fruit, either for direct consumption or as raw material for the processing industry, the proper determination of the ripeness is paramount. Ripeness classification in bananas is still largely done using human experiential judgment, which yield inconsistent results, is subjective and often prone to error (Gunasekaran, 2000). This method is ineffective to cope with the increasing volume demand for banana as well as post-harvest handling and processing. Therefore, non-destructive methods of determining quality attributes and the ripeness of bananas are imperative.

The optical method is one of the non-destructive approaches that has gained a huge amount of attention in recent years (Mohd Ali et al., 2017; Adebayo et al., 2016). Hashim et al. (2012) investigated the colour changes in banana with the onset of chilling injury symptoms. The study used the first-order kinetic model to fit the kinetics of red (r), green (g) and hue (H) colour parameters. It was found that there was a correlation between r, g and H colour parameters with visual assessment. It was also revealed that there is a

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