Laser-based imaging for cocoa pods maturity detection

ABSTRACT

Non-destructive and laser-based technologies have been explored widely in recent years as a way to monitor fresh produce and crops quality in the agriculture sector. In this study, the effectiveness of laser-induced backscattering imaging (LLBI) was investigated to determine the firmness and colour of cocoa pods at different maturity stages. The LLBI system with 1 mm laser diode beam diameter emitting at 658 nm and 705 nm wavelengths were used to capture backscattered images of Theobroma cacao at three different maturity stages, which were unripe, ripe and over-ripe. The samples were also measured using reference measurement such as colorimeter and handheld penetrometer for measuring colour and firmness, respectively, in order to compare with the LLBI. Results indicated that chroma (C) regressed linearly well with the backscattering parameters with a coefficient of determination (R^2) of 0.755 for 658 nm and 0.800 for 705 nm. Classification of samples according to their maturity stages resulted in 90% correctly classified samples into an unripe group using a laser diode at 658 nm and 95% at 705 nm. These findings also revealed that LLBI with laser diode emitted light at 705 nm wavelength gave better evaluation and classification results compared with 658 nm. This study has demonstrated the ability of non-destructive LLBI technique to evaluate the maturity stages of cocoa pods.

Keyword: Laser-based imaging; Backscattering imaging; Fruit maturity; Cocoa; Non-destructive technique