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Mini Review

A review of non-destructive techniques applied for measuring quality of oil palm fresh fruit bunches

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Abstract

The quality of oil palm fruits is evaluated through several characteristics such as the ripeness level, oil content, and free fatty acid. Besides human visual assessment and destructive techniques, another alternative method that provides quality assessment on oil palm fresh fruits bunches (FFB) is through the application of non-destructive techniques. A few of the non-destructive techniques are covered in this review such as machine vision system, visible or near infrared spectroscopy, image processing using relative entropy, fluorescence technique, Kinect camera, and optical sensor system. The main quality parameter that is being evaluated is the ripeness level of the FFB because the maturity of FFB has a direct impact on the quality of the extracted oil that will eventually affect the economic value of palm oil.

1. Introduction

Elaeis guineensis (subsps. Nigrescens) is known to be a commercial and popular oil palm species that is grown in Malaysia, which consists of three varieties which are *tenera*, *dura*, and *pisifera* (Hazir et al., 2012). According to Kushairi et al. (2019), Malaysia produced 17.16 tonnes oil palm fresh fruit bunches (FFB) every hectare in 2018. Malaysia's export earnings of palm oil and oil palm products were RM65.12 billion in that same year.

The quality of oil palm fruits is evaluated through several characteristics. Colour is the main characteristic to detect the ripeness of a fruit. Human visual perception is often used to differentiate colours but the outcomes may be varied and inconsistent due to physical and psychological state of humans (Makky, 2016). Furthermore, the quality of the fruit can also be checked by the amount of oil content as well as free fatty acid that significantly affect the quality of palm oil produced. Assessment on oil content and free fatty acid is normally via chemical analysis at laboratory which is costly and time consuming as well as destructive to the samples (Makky & Soni, 2014).

Besides human visual assessment and destructive techniques, another alternative method that provides quality assessment on oil palm FFB is through the application of non-destructive techniques. Non-destructive techniques are proven to be reliable and efficient using advanced technologies with data handling and processing. Harun et al. (2013) stated that numerous automated fruit grading systems were proposed and their functionalities were tested in the past few years. A few of the non-destructive techniques are covered in this mini review such as machine vision system, visible or near infrared spectroscopy, image processing using relative entropy, fluorescence technique, Kinect camera and optical sensor system.

2. Physiology and quality of oil palm

Harvesters in oil palm sector are required to follow grading standard guidelines in order to avoid misclassification of oil palm ripeness. A summary of the grading standards established by Malaysian Palm Oil Board (MPOB), Sime Darby Palm Oil Mill and other experienced FFB mill graders are represented in Table 1 (Harun et al., 2013; Hazir, Shariff, & Amiruddin, 2012). The first grading method is to identify the total number of empty sockets on the bunch and the colour of mesocarp. Mesocarp with yellow colour is considered as unripe whereas orange colour is categorized as ripe. Another method is to determine the FFB ripeness by basing on the number of detached fruitlets. The oil palm FFB is classified as ripe when the fruits detached from the bunch are between 10 to 50 %. Different ripeness level of FFB has different surface colour and condition as depicted in Figure 1.

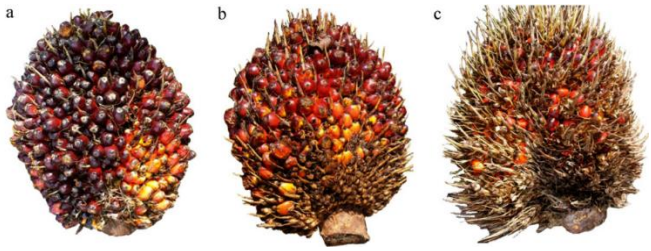

Figure 1. Oil palm FFB surface colour and condition in different categories or ripeness; (a) under-ripe; (b) ripe; and (c) over-ripe (Hazir, Shariff, & Amiruddin, 2012)

According to Makky and Soni (2014), the level of oil palm fruits or bunches ripeness can be determined by computing the ratio of carotenoids to chlorophyll pigments in fruit skin or vice versa. In raw fruits, the presence of chlorophyll is the highest whereas the carotenoid is the lowest. As the ripening process

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