Quality evaluation of mango using non-destructive approaches: A review

Ong Phey Zhen[a,*], Norhashila Hashim[a,b], Bernard Maringgal[a]

[a]Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
[b]SMART Farming Technology Research Centre (SFTRC), Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.

ARTICLE HISTORY	Abstract
	Mango (*Mangifera indica* L.) is one of the most popular and nutritionally rich fruits. It is also acknowledged as the king of fruits in India. Quality attributes of mango fruit depends on its appearances such as size, shape, skin colour, flesh colour, flavour, sweetness, and aroma. Over the recent years, non-destructive techniques have been garnering the interest of researchers as potential technologies that can be used for quality assessment of fruits in a part of postharvest processing. The present patterns of non-destructive techniques are more efficient, inexpensive, yield faster and accurate results. This mini review paper focuses on some of the previous applications of non-destructive techniques in quality evaluation of mango, focusing specifically on the non-destructive technique based on quality parameters. The future trend of using non-destructive techniques for quality evaluation is also discussed in this review paper.

1. Introduction

Mangoes belong to genus *Mangifera* which consists of about 30 species of tropical fruiting trees in the flowering plant family of *Anacardiaceae*. Mango (*Mangifera indica* L.) is one of the most well-known and nutritionally rich fruits. It is also acknowledged as the king of fruits in India. Mango fruits can be eaten, and it contains high moisture content that is well known for its intense peel coloration, flavourful taste, and high nutritive value of vitamin C, β-carotene, and minerals (Tharanathan et al., 2006). Mango fruits vary in size, shape, colour, flavour, taste, and several other attributes depending upon its variation. The unripe mango fruit has green skin and it will change colour to yellow, orange, purple or red as the mango fruit is ripening. Mature mango fruit has a fragrance smell and is smooth in texture (Barton, 2005).

The largest mango producer in the world is India whereby it consists of nearly 36 % of total fruit plantation area and 40 % of their total fruit production (Sharma & Krishna, 2017). Mango is also one of the well-known fruits in Malaysia for both domestic and global markets. Federal Agricultural Marketing Authority (FAMA) is in charge of the quality of many fruits going into the market in Malaysia as it has propelled Malaysia's Best label which represents the standard for quality fruits. All fruits are required to be classified and examined by Malaysia's Best quality determination under this label, for example, size, appearance and ripening index (Mansor et al., 2014).

Nowadays, consumer demand for high-quality fruit is increasing, the evaluation and identification of fruit quality have become a concern in the postharvest processing. Ripeness, colour, size, external defects such as disease infection and injuries are significant surface quality parameters of mango while sweetness, aroma, internal defects, nutrient and water content are major parameters for internal quality of mango fruits (Gajanan et al., 2015). Physical (size, shape, surface colour), biochemical (acidity, soluble solids content, aroma), and physiological (changes in the skin or flesh colour) parameters are used to interpret the ripening phase for harvesting of fruits (Jha et al., 2010).

In the past, the evaluation of internal and external qualities of fruits was mostly carried out using destructive measurement and the rest are based on the optical appearance and defects of the fruit which could result in imprecise measurement. In addition, evaluation carried out by human sorting depends very much on human labour and is time consuming (Hashim et al., 2012). Non-destructive testing (NDT) is an investigation method utilized in science and innovation industry to evaluate the properties of material, component or system without causing internal damage (Sanchez et al., 2020). Non-destructive technique gives impressive results when used correctly and most importantly it allows the material to be analysed without changing or destroying their usefulness and simultaneously improves the product reliability, prevents accident, and lowers costs as compared to destructive testing.

The intention of this paper is to review the recent research paper on the quality evaluation of mango using non-destructive techniques. The non-destructive techniques discussed in this paper include: Near infrared spectroscopic (NIR), Scanning Laser Vibrometry (SLV), X-ray and Computed Tomography (CT), Computer vision system (CVS) and image processing, Electronic nose, RGB Fiberoptic colour sensor and Ultrasonic.

2. Quality assessment

Quality is known as a marker of the subjective perception of explicit parameters, which can be analysed differently from different prospects (Fukada, 2013). The quality of fruits is described using essentially four attributes which are colour and appearance, flavour (taste and aroma), texture and nutritional value (Barrett et al., 2010). Quality evaluation of mango determines the physicochemical properties and defects of the fruit during storage. The appearance of fruit decides whether it is accepted or rejected by consumers; so it is the most critical quality attribute (Bureau, 2009).

2.1 External attribute and quality of mango

External attribute is necessary and important as it is