The Measurement of Soluble Solids Content in Snake Fruit (*Salacca Edulis Reinw*) cv. Pondoh Using A Portable Spectrometer

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Abstract: In this research we reported the use of near infrared spectroscopy for nondestructive soluble solids content (SSC) measurement in intact snake fruit (*Salacca edulis Reinw*) cv. Pondoh. The spectra of 100 samples were acquired in the range of 300-1040 nm using an available, low cost portable spectrometer (VISNIR USB4000). The spectrometer used an array of linear CCD as a detector. The LS-1 Tungsten Halogen lamp is used as light source. This system is also equipped with a fiber optic. Snake fruits were placed on the sample holder and the spectra were measured using 100 ms of integration time and 50 scans for averaging. The spectra were acquired in two different positions in the middle of fruit. The total scanning time was 10 s for each fruit. The SSC of snake fruits were measured destructively following the spectra measurement using a digital refractometer. A portion of snake fruit flesh with associated with the point of spectra measurement was cut and juiced. Then the juice of snake fruit was placed on a digital refractometer. The SSC was quantified in Brix value. The trial free version of The Unscrambler V.9.1 was used as chemometrics tools to extract the useful information from the spectra. The calibration model was developed using Partial Least Squares Regression 1 (PLSR1) for three types of spectra, original, smoothing and second derivative spectra. The calibration model was evaluated using some parameters such as coefficient of determination (R^2), standard error of prediction (SEP), bias between actual and predicted SSC value and ratio prediction to deviation (RPD) parameter. The possibility of using near infrared spectroscopy to measure SSC of intact snake fruit nondestructively was successfully demonstrated. The best calibration model with 3.32 of RPD value could be obtained.

Keywords: snake fruit, near infrared spectroscopy, intact fruit, soluble solids content, nondestructive method, ratio prediction to deviation

1. INTRODUCTION

There is an increasing in the consumption of tropical fruits as ingredients of diets in the world such as Europe and North America (Gorinstein et al. 2009). Indonesia, which has many exotic tropical fruits such as mangosteen, pineapple and snake fruit, can be main exporter of tropical fruit to provide tropical fruits which high quality. For this purpose, a non-destructive quality evaluation of the tropical fruits to meet the export market criteria is important to be considered.

The use of near infrared spectroscopy as non-destructive quality evaluation seems to be a good choice since that this technique has become popular and ready to use. Many researchers have reported the successful application this technique in measuring internal quality of several fruits. It has been demonstrated that near infrared spectroscopy, especially in the short wavelength are highly correlated to the SSC of apples, mangos, oranges, pears, tomatoes, kiwi fruits, and etc. (Subedi et al. 2007; McGlone et al. 2002). A complete review of using near infrared spectroscopy technique for internal quality inspection in fruits is well described by Nicolai et al. (2007). In the review, it is clearly that many researchers use this technique with various kind of near infrared wavelength range and sample presentation. Some of them use visible and short wavelength 700-1100 nm (Ventura et al. 1998; McGlone et al. 2002; Temma et al. 2002; Saranwong et al. 2003; Walsh et al. 2004) and others use short and long wavelength 700-2500 nm (Guthrie and Walsh 1997; Ying et al. 2005). Reflectance and interactance (also similar to absorbance) are widely used for sample presentation. The near infrared instrumentation was developed rapidly and now there is an increasing of using a low cost and portable NIR instrumentation for measuring internal quality of fruits and vegetables, especially for soluble solids content (SSC) determination (Temma et al. 2002; Saranwong et al. 2003). As mentioned by Gorinstein et al. (2009) snake fruit has similarity in characteristic with kiwi fruit such as polyphenols content and antioxidant value. Both fruits are recommended for good diet ingredients. For kiwi fruit, the use of near infrared spectroscopy has already conducted with promising result (r = 0.99 and SEC = 0.72%Brix for SSC determination) (Slaughter and Crisosto, 1998). Recent work also confirmed the successful result of using FT-NIR diffuse reflectance spectroscopy in measuring the firmness of kiwi fruit (Fu et al. 2007). However, the use of a portable near infrared spectroscopy instrumentation for non-destructive measurement of SSC in intact snake fruit has not yet been reported

For snake fruit especially `pondoh` cultivars, the quality of product mainly determined by its sweetness. However, it is very common that the degree of sweetness vary due to different place of cultivation. To export snake fruit, it is important to sort the product based on the homogeneity in degree of sweetness. In this research, a potential use of a low cost and portable NIR spectrometer to measure SSC of snake fruit will be proposed. Then the calibration model for predicting the SSC of snake fruit will be developed and validated.

2. MATERIALS AND METHODS

2.1. Materials

A number of 100 snake fruits (*Salacca Edulis Reinw*) cv. Pondoh were used. This snake fruit is originated from Indonesia. The fruits were harvested from the same orchard at Lampung province, Indonesia. To obtain a wide range of SSC measurement, two groups of sample were selected. The first group was samples with high SSC; most of them are big in size and dark in skin appearance. The second one was samples with relatively low SSC; most of them are small in size and clear in skin appearance. The expert farmer did this selection. The spectral acquisitions were done in the same day of harvest time.

2.2. Spectra measurement method

The spectra of snake fruits were acquired in absorbance mode using a low cost and portable spectrometer (VIS-NIR USB4000, The Ocean Optics, USA). This spectrometer has wavelength range 300-1040 nm. The spectrometer used an array of linear silicon CCD as a detector. The LS-1 Tungsten Halogen lamp is used as light source. This system is also equipped with a fibre optic (2 m in length and 400 μm of its probe diameter). Snake fruits were placed on the sample holder and the spectra were measured using 100 ms of integration time and 50 scans for averaging. A diffuse reflectance standard reference (model WS-1, The Ocean Optics, USA) measurement was made every time prior to a sample spectra acquisition. The spectra were acquired in two different positions in the middle of fruit as shown in the Fig.1. Therefore, the total scanning time was 10 s for each fruit. As the temperature has a considerable effect on the near infrared spectrum of chemical component, it needs to avoid the fluctuating of temperature of sample (Maeda et al. 1995). For this purpose, the sample temperature was maintained at 25°C using a water bath prior to the spectra measurement (Peirs et al. 2003).

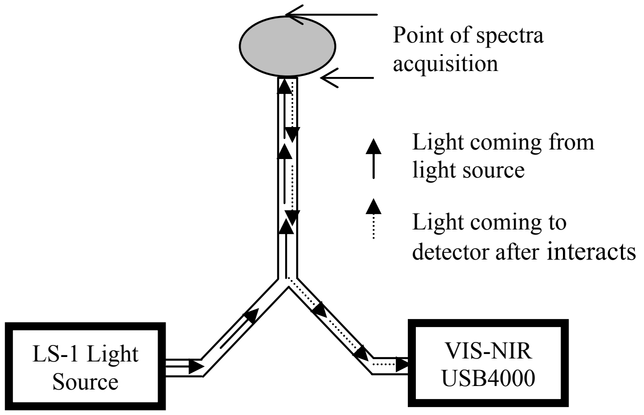

Fig. 1. The spectra acquisition of intact snake fruit in absorbance mode in two different positions.

2.3. The reference method

The SSC of snake fruits were immediately measured destructively following the spectra measurement using a digital refractometer (model PR-201α (Brix 0.0-60.0%), ATAGO, Co., Tokyo, Japan). This refractometer has measuring accuracy ±0.1% and measurement temperature 10-40°C (automatic temperature compensation). The temperature of the samples for SSC measurement was not measured. However, since that the SSC measurement was conducted at the room temperature, the influence of the temperature to the SSC measurement using this refractometer could be negligible. A portion of snake fruit flesh with associated with the point of spectra measurement was cut and juiced. Then the juice of snake fruit was placed on a digital refractometer. The SSC was quantified in Brix value. Then the average of two SSC measurements was used as a reference value. In order to predict the reference parameter (SSC), calibration and validation sample sets were performed. Table 1 showed the descriptive statistics of calibration and validation samples used for developing calibration model and performing validation test.

Table 1. Descriptive statistic of samples used for developing calibration and validation in intact snake fruit.

Item	Calibration sample set	Validation sample set
Number of samples	50	50
Minimum value	12.10	12.00
Maximum value	20.15	20.10
Mean	16.13	16.27
Standard deviation	2.95	3.06
Unit	%Brix	%Brix

2.4. Spectra analysis

In this research, a short near infrared wavelength range of 700-1040 nm will be used for further analysis. Relative absorbance spectra were calculated by using (1) (Suhandy 2009):