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อิทธิพลของตำแหน่งผลมะม่วงต่อการประเมินคุณภาพด้วยเนียร์อินฟราเรดสเปกโทรสโกปี
Effect of mango fruit sampling position on quality assessment by near infrared spectroscopy

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Abstract

The purpose of this research was to study the effect of mango fruit sampling position on the repeatability of measuring spectra for quality assessment by near infrared spectroscopy (NIRS). Three positions on unripened and ripened mango fruits (cv. Nam Dok Mai Si Thong) were chosen: the shoulder, the cheek and the tip (or beak). The fiber optic probe of NIRSystem6500 was placed in contact with the fruits at each position and spectra were obtained from 700 nm to 1100 nm. Statistical software was used to analyze the variance of the spectral data. It was found that the spectra clearly showed a peak at 978 nm which is the water absorption band. The absorbance of water at the cheek of unripened and ripened mango fruits were 1.16 and 1.08 respectively, which were significantly higher ($P<0.05$) than at either the shoulder or the tip. At these positions, the absorbencies were 1.03, 1.03, and 1.02, 0.98 for unripened and ripened fruits, respectively. In addition, the coefficient of variation of the absorbance at the cheek of both unripened and ripened fruits were 6.9 % and 6.5 %, respectively, lower than at either the shoulder or the tip (14.6%, 8.7 % and 16.7%, 12.2% for unripened and ripened fruits, respectively). It can be concluded that the position on a mango fruit at which a spectrum is obtained affects the variance of NIRS measurements, which will relate to the precision of quality assessment.

Key word: fruit position, quality, near infrared spectroscopy

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาอิทธิพลของตำแหน่งบนผลมะม่วงในการวัดสเปกตรัมเพื่อประเมินคุณภาพด้วยเทคนิคเนียร์อินฟราเรดสเปกโทรสโกปี นำผลมะม่วงพันธุ์น้ำดอกไม้สีทองทั้งผลดิบและผลสุกวางบนไฟเบอร์ออฟติคโพรบ จากนั้นวัดสเปกตรัมของผลมะม่วงในตำแหน่งไหล่ แก้ม และปลายผล ด้วยเครื่อง NIRSystem6500 ในช่วงความยาวคลื่น 700 ถึง 1100 นาโนเมตร วิเคราะห์ความแปรปรวนของข้อมูลสเปกตรัมด้วยโปรแกรมทางสถิติ ผลการทดลองพบว่า สเปกตรัมของผลมะม่วงพบพีคที่ชัดเจนที่ความยาวคลื่น 978 นาโนเมตร คือ แถบการดูดกลืนแสงของน้ำ ค่าการดูดกลืนแสงของน้ำในผลมะม่วงที่ตำแหน่งแก้มของทั้งผลดิบและสุก มีค่าเท่ากับ 1.16 และ 1.08 ซึ่งสูงกว่าในตำแหน่งไหล่และปลายผล ซึ่งมีค่าเท่ากับ 1.03, 1.03, และ1.02, 0.98 ตามลำดับ โดยมีความแตกต่างอย่างมีนัยสำคัญทางสถิติ($P<0.05$) นอกจากนี้สัมประสิทธิ์ของความผันแปรของค่าการดูดกลืนแสงของน้ำ ตำแหน่งแก้มผลมะม่วงทั้งผลดิบและสุกมีค่าเท่ากับ 6.9 และ 6.5 ต่ำกว่า ตำแหน่งไหล่และปลายผล ซึ่งมีค่าเท่ากับ 14.6, 8.7 และ 16.7, 12.2 ตามลำดับ จากผลการทดลองสรุปได้ว่าตำแหน่งของผลมะม่วงมีอิทธิผลต่อความแปรปรวนของสเปกตรัม NIRS ซึ่งสัมพันธ์กับความแม่นยำในการประเมินคุณภาพมะม่วงด้วยเนียร์อินฟราเรดสเปกโทรสโกปี

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Introduction

Near infrared spectroscopy (NIRS) is a non-destructive technique for quality assessment on pharmacy, petroleum, sugar industry and agro-industry for more than 20 years. Presently, NIRS is applied to assess the quality of agricultural production such as cereals, some vegetables and fruits. Since it is low cost of operation,

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short time analysis and produces less waste (Iwamoto et al., 1995). However, there are many factors affecting the precision of the NIRS results. The sources of error in NIRS testing are factors associated with the instrument, factors associated with the sample and operational factors (Williams and Norris, 2001). The instrument factors are wavelength scale, photometric scale, instrument temperature, cell covers, relative humidity of atmosphere, instrument-instrument differences (Saranwong et al., 2003) and sample presentation (Schaare and Fraser, 2000). The sample factors are chemical composition, bulk density, physical texture of sample, external factors, sample temperature, ambient temperature, conversion factors, whole grain application (McGlone and Kawano (1998); Li et al. (2007); Kawano et al. (1995); Peirs et al.(2003)). The operation sources are calibration practice number, sample preparation, sample storage, sample cell loading and general careless (Krivoshiev et al., 2000). The most troublesome sources of error are likely to be instrument to instrument variability with respect to wavelength , sample selection for calibration, sampling and sample preparation, wavelength selection and reference laboratory analysis (Williams and Norris, 2001). So, the purpose of this research was to study the effect of mango fruit sampling position on quality assessment by near infrared spectroscopy.

Materials and methods

Mango fruits cv. Nam Dok Mai Si Thong were harvested at the commercial grade from Phitsanulok province. They were carried to the Postharvest Technology Research Institute, Chiang Mai University. A total of 120 mango fruit were divided into two groups, first group was the unripened mango and second group was the ripened mango which were stored at 25 °C for 7 days. Before measuring the spectrum, mango fruits were kept in the chamber at 25 °C for 3 hours to adjust the temperature. Three positions on unripened and ripened mango fruits were chosen: the shoulder, the cheek and the tip (or beak). The fiber optic probe of NIRSystem6500 was placed in contact with the fruits at each position and spectra were obtained from 700 nm to 1100 nm in interactance mode. Statistical software was used to analyze the variance of the spectral data.

Result and discussion

The original and mean spectra of mango fruit were showed in Figure 1 and 2. A clear peak at 978 nm is the water absorption band (Saranwong et al., 2003). The absorbance of water at the cheek of unripened and ripened mango fruits were 1.16 and 1.08 respectively, which were significantly higher ($P<0.05$) than at either the shoulder or the tip.

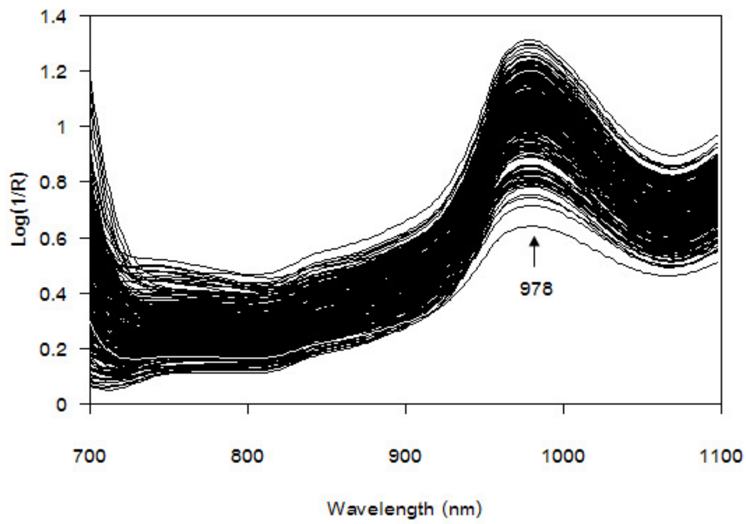

Figure1 Original spectra of mango fruit measured at the shoulder, the cheek and the tip.

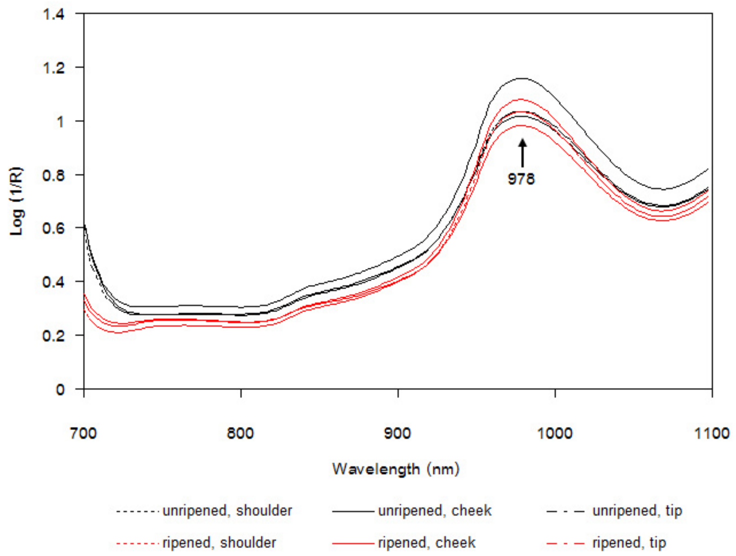

Figure 2 Mean spectra of mango fruit measured at the shoulder, the cheek and the tip.

At these positions, the absorbencies were 1.03, 1.03, and 1.02, 0.98 for unripened and ripened fruits, respectively (Table1). In addition, the coefficient of variation of the absorbance at the cheek of both unripened and ripened fruits were 6.9 % and 6.5 % respectively, lower than at either the shoulder or the tip which were 14.6%, 8.7 % and 16.7%, 12.2% for unripe and ripe fruits, respectively. These are the effect of sampling positions. The shoulder, the cheek and the tip of mango fruit affected light reflectance in interactance mode, since the different of the contact surface of mango fruit at the end of the probe. In the case of interaction, an interactance probe is composed of a concentric outer ring of illuminator and an inner portion of receptor. The end of the probe should be contacted with the surface of the sample (Kawano, 2002). So, the cheek of mango fruit was the best sampling position to reduce an error of NIR measuring spectrum. Similary to Saranwong (2003) reported that the spectra of mango fruit cv. " Mahajanaka" and "Caraboa" were measured at the shoulder ((90 degree from the fruit stem – axis): the cheek). It showed the high precision calibration equation. Moreover, an error from small differences could be minimized by including the data in the calibration (Williams and Norris, 2001).

Table 1 Absorbance (Log(1/R)) of water content of mango fruit at three sampling positions.

Fruit sampling position	Unripened mango (Log(1/R) at 978 nm)	Ripened mango (Log(1/R) at 978 nm)
Shoulder	1.03*	1.03*
Cheek	1.16*	1.08*
Tip	1.02*	0.98*
CV (%)	12.9	9.36

* means significant difference at 95 % confidence.

Conclusion

The mango fruit sampling position affects the variance of NIR measurement. It can be reduced by acquisition of the spectra at the cheek of fruit.

Acknowledgement

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