Nondestructive Detection of Fruit Fly Eggs and Larvae in Mango by Near Infrared Spectroscopy

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[Introduction] Fruit fly is one of the important pests from the point of plant quarantine. In order to prevent the spreading of fruit flies from South East Asia to Japan, tropical fruits that may be the host of this insect should be disinfected by vapour heat treatment. However, the vapour heat treatment can cause quality deterioration in fruit at some extents. In this study, in order to maintain the quality of exported fruits, near infrared (NIR) spectroscopy had been examined for its potential to classify fruit fly infested mangoes from the clean ones.

[Materials and Methods] One hundred and two green mangoes were used; 92 sampleswere used as control while another 92 samples were used as infested samples. At first, nine pores with 2 mm depth were made on the fruit shoulder in the area of 1 cm^2 using a sterile sewing needle. The artificial infestation was done by placing the pored fruit in a fruit fly cage for 30 minutes. NIR measurement was performed with the FQA-NIR Gun (Shizuoka Shibuya Seiki, Hamamatsu, Japan) in the short wavelength region (588-1092 nm) using the Interactance mode (Figure 1). The measurements were performed at 0, 24, 36 and 48 hours after infestation. Prior to NIR measurement, sample temperature was controlled by dipping the fruits into 25°C water bath for 15 minutes. A polyethylene sheet was used to cover the surface of water to prevent the fruits from getting wet.

Data analysis was carried out using "The Unscrambler" software (CAMO, Oslo, Norway). Second derivative spectra (Savitzky-Golay algorithm, left and right averaging of 28 nm and 2^{nd} order polynomial) were used. Partial least square (PLS) regression was used to predict the classification value of "0" (control group) and "1" (infested group). Validation was performed by leave-one-out full cross validation.

[Results and Discussion] Visually, there were no differences between second derivative spectra of control and infested mangoes. By the effect of water absorption, neither fat band nor protein band due to the present of fruit fly eggs could be observed in the NIR spectra of forced infested mango. Using PLS regression, the results shown in Table 1 could be obtained. It was found that the classification performed at 48 hours after infestation could provide satisfied results with only 2 false negatives of a total of 48 samples (4.3 %). The regression coefficient plots indicated that the absorption due to in the vicinity of 730 nm had an important role on the classification (Figure 2). The peak was considered to be the protein absorption band of fruit fly larvae, for only the dried fruit fly larvae absorbed the NIR radiation in this region.

Figure 1. NIR measurement of mango

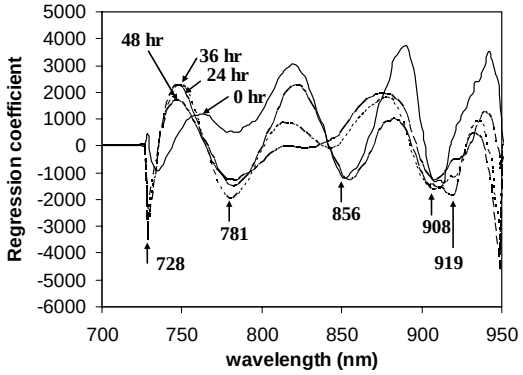

Figure 2. Regression coefficient plots.

Table 1. PLS classification results calculated from second derivative NIR spectra.

Period after infestion	Wavelength (nm)	F	Number of fruits					
			Infested			Control		
			Correct	False	SD	Correct	False	SD
00 hr	700-950	6	59	37	0.28	74	22	0.17
24 hr	700-950	7	89	7	0.26	93	3	0.20
36 hr	700-950	7	86	10	0.26	93	3	0.19
48 hr	700-950	7	90	6	0.26	95	1	0.16

SD: Standard deviation of NIR-predicted value