White Root Disease Infected Rubber Tree Detection Through Statistical Inference of Dry Rubber Sheet Near Infrared (NIR) Spectrum Measurement Method

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ABSTRACT

In this paper, the aim of this project is to analyze the acquired information based on Near Infrared (NIR) measurement on dry rubber sheets with respect to white root disease (WRD) infected rubber tree. Then, it will be evaluated statistically using SPSS. WRD is the most serious disease where it can be spread to another tree by root to root. The tree will die slowly once it is infected by WRD. Prevention of WRD is needed to avoid higher losses in a rubber plantation. Hence, this leads the investigation in detecting WRD to overcome the problem through dry rubber sheets. Up till now there is no information and research about the WRD based on NIR spectrum through the dry rubber sheet as a subject. The measurement of NIR via dry rubber sheet using spectrometer MCS600 attached with measuring head OFK 30. NIR spectrum measurement was applied to 7 different regions of Interest (ROI) at dry rubber sheets. The outcome from measurement produces the spectrum responses which are lower peak and upper peak. The output spectrum responses obtained from the experiment are recorded and analyzed using skewness method. The SPSS software is used to analyze the skewness value. From the statistical result, it can be summarized that, healthy and WRD rubber tree can be discriminated from each other through dry rubber sheet using skewness method since the results from analysis produced significant difference at the lower peak in both cases.

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Introduction

Rubber tree or its scientific name Hevea brasiliensis originated from Brazil and it has been a major tree crop widely cultivated in South East Asia [1, 2]. This species is prominent to grown commercially in many countries and it produces the natural rubber latex [3]. The other countries involved in the consumption of natural rubber other than Malaysia are China, India, Japan, Indonesia, USA and Thailand [4].

The most serious disease in Malaysia is WRD and it plays as a destructive agent to the rubber plantation [5]. Once it has been infected, the trees will die slowly. Symptom of WRD can be recognized by expertise through its physical symptom such as discoloration and deformation of leaves as well as occurrence of fungus at root trunk located above the ground [6]. Hence, conditions such as plantation and protection from disease need to be considered because they will disrupt the growth of the rubber tree [7]. Therefore, prevention is better than treatment because it takes time to treat and costly [8]. Detection of white root through physical symptom is categorized as external feature detection. It is a practical and a possible idea to investigate detection using physical particularly of dry rubber sheet with respect to WRD.

Regarding recent studies, there is no evidence from literature review that is related to the use of dry rubber sheet as a subject in determining WRD using NIR spectrum technique. Thus, it is important to investigate the new way for rubber plantation in detecting a technique for the prevention of this disease to avoid losses of production. The current investigations of disease were on leaf disease [9-11] and latex [12]. Also, there were investigations on WRD [6, 13] with respect to optical properties. Based on the finding of this work, it shows the reliability in detecting WRD using this technique.

NIR range lies beyond the visible light from 770nm to 2500nm [14]. In this region, infrared light is transmitted to any material producing magnetic radiation that can influence its bonding [15]. Hence, it can be hypothesized that quantifications of properties using NIR spectrum are affected if exist abnormality in the health condition of the tree with respect to its appropriate wavelength. The NIR spectrum technique is mostly used in agriculture, instrumentation, medical and food science. The application of NIR can be observed in the grading of watermelon [16], measuring the moisture content of latex [17] and classification of clone series in latex [18]. This technique is also rapid, accurate, non-destructive and suitable to be used in experimental fields [19]. The purpose of this research is to measure the dry

rubber sheet in the detection of white root infected rubber tree based on optical properties.

Materials and Methods

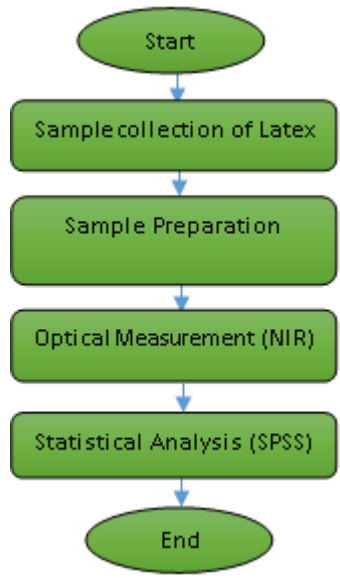

Figure 1: Flow Chart of the Process

Flow chart of overall process

Figure 1 shows the overall process of determining healthy and WRD latex via NIR spectrum using statistical analysis.

Sample collection

Two types of latex sample from healthy and WRD rubber latex are collected at Rubber Research Institute Malaysia (RRIM) Kota Tinggi, Johor. A total of 12 healthy and 12 WRD latex samples was taken for this work. All the samples were identified from two groups of RRIM2000 series and RRIM3000 series. The selected clones are from 3001 and 2002. Every clone represents six latex samples in each case. The choices of these clones as the main subject for this work are based on its availability latex production for WRD case during the sample collection and recommended by RRIM. The minimum quantity of 25ml of sample latex must be collected for every tree in order to complete the experiment in sample preparation. The determination of WRD is necessary in recognition of cases before collecting the sample. It was done several days before collection phase by expertise from RRIM Sungai

Buloh and RRIM Kota Tinggi itself [20]. The determination method is based on tree morphology and presence of fungus in the root of rubber tree. Once the sample has been collected, all samples are added with preservative for avoiding the process of coagulation. Later, all the samples are converted from latex into dry rubber sheets.

Sample preparation

The sample was prepared using standard Laboratory Method (SLM) developed by Malaysian Rubber Board (MRB) [21], since this method is accurate and well established [22]. This process transforms the liquid (latex) to dry rubber sheet. This method involves the coagulation, expelling water and drying using oven using quantity 25ml of latex samples for every sheet. Then, NIR spectrum will be measured on dry rubber sheets using the spectrometer.

Optical measurement (NIR)

In this work, the proposed optical measurement method is the NIR technique. The optical properties are used in order to observe through every sample sheet. The dry rubber sheets were measured using spectrometer MCS600 with measuring heads OFK30. The measuring sensor is from OFK30 measuring head. NIR spectrum was applied to determine the spectral response in dry rubber sheets. The spectra were obtained in absorbance mode; thus, resulting peak and valley of spectral responses in the NIR region between healthy and WRD. Each of the sheets will be divided into seven regions of interest (ROI) that represent healthy and WRD case. The experiment was conducted in ASP lab, Faculty Electrical Engineering, UiTM Shah Alam. The absorbance measurement results were gained using interfaced with aspect plus software to extract information from the spectrometer and transferred into Microsoft Excel for further analysis.

Statistical Analysis

Statistics in this research was described using Statistical Packages of Social Sciences (SPSS) software. The preliminary analysis of the measurement data is needed in the numerical or statistical analysis in order to perform the research effectively. Observation of NIR measurement nshowed that the curve shape was produced at lower and upper peak. Basically, shape characteristics are often used to elaborate skewness measurement [23]. Therefore, the skewness method is used in finding the shape characteristics and discriminating information due to healthy and WRD cases. The skewness value was obtained from SPSS software. After that, skewness value was applied to normality test and parametric statistical test for inference information in discriminating the two cases.

Result and Discussion

Optical measurement

Figure 2 shows the example outcome from the optical measurement of dry rubber sheet samples. It is extracted from Aspect Plus software in terms of the graph. This figure indicates the spectrum response. As shown in this figure, the response produces two peaks which are lower and upper peak. The x-axis represents wavelength range while the y-axis is absorbance value. The range of NIR spectral wavelength is from 948.89nm to 1637.72nm. There are 35 wavelength readings obtained at each peak for both cases.

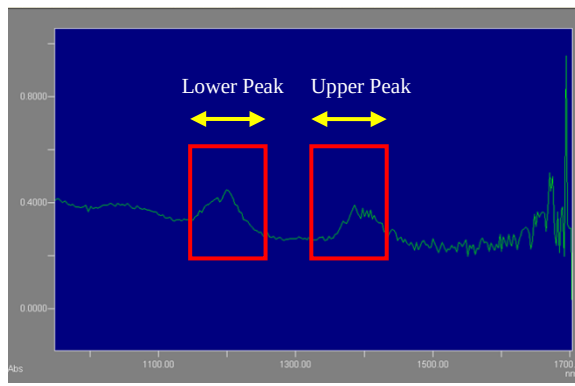

Figure 2: Example of Optical Measurement

Skewness method

Figure 3 represents the relationship between the location of mode, median and mean from skewness method. The values were obtained from SPSS software at each spectrum response for both cases. The shape for each spectrum response would be represented in terms of its skewness measurement which is based on the relationship between location mode, median and mean. This figure indicates that WRD can be discriminated from healthy with respect to lower peak, but upper peak shows otherwise due to overlapping. Therefore, this can probably can be used for further analysis using normality test and parametric test. Skewness information about the peaks would be the identified feature for statistical test. The next section will discuss the statistical findings using skewness method.

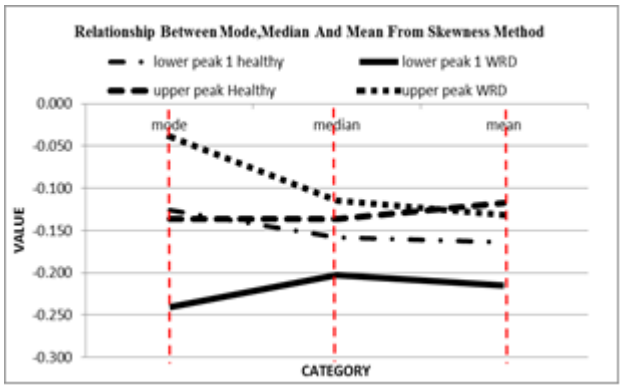

Figure 3: Relationship between Mode, Median, and Mean from Skewness Method

Boxplot

The boxplot from skewness measurement is as shown in Figure 4. For lower peak data, boxplot for both healthy and WRD group shows no outlier. From the observation, lower peak measurement is located, 50% quantile in the middle and their whiskers have similar distance. This indicates normal distribution. In contrast, upper peak measurement shows it is not normal because there are outliers for both healthy and WRD latex. All information is not conclusive and needs to be tested for normality test.

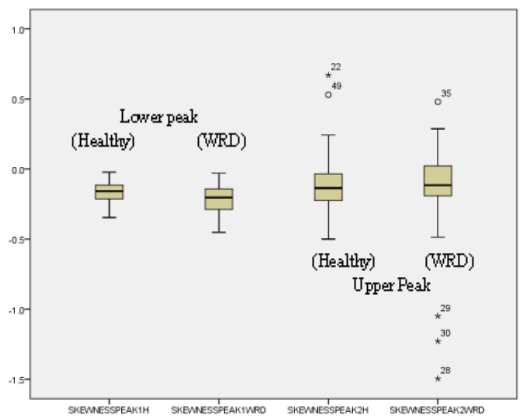

Figure 4: Boxplot for Both Peaks

Normality Test

In this test, the statistical method used to check the normality is the Kolmogorov-Smirnov (K-S) Test for quantitative results. Table 1 shows the

normality test results for both peaks with respect to healthy and WRD latex. It is observed that lower peak is normally distributed for healthy and WRD latex. The data implies having a normal distribution since the Sig. P-value is greater than 0.05. Otherwise, the data is not normally distributed when the Sig. P-value is below than 0.05. Therefore, lower peak is qualified for testing using error bar.

Table 1: Normality Test for Lower Peak and Upper Peak

	Kolmogorov-Smirnov		
Peak	Statistics	df.	Sig. P-value
Lower peak Healthy	0.063	84	0.200
Lower peak WRD	0.097	84	0.064
Upper peak Healthy	0.119	84	0.005
Upper peak WRD	0.187	84	0.000

Error bar

Figure 5 depicted the error bar plots with respect to healthy and WRD latex for lower peak. The error bar represents 95% confidence interval when locating population means for both healthy and WRD latex. It is observed that, healthy and WRD latex shows significant difference, and both plots are not overlapping between each other. As a result, this test was able to prove that lower peak was selected to be reference of this project and reinforced by paired sample t-test in the next section.

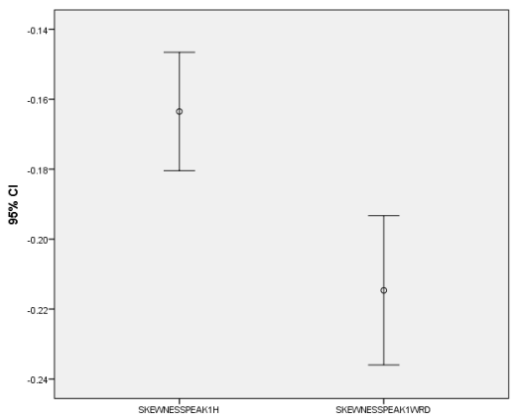

Figure 5: Error bar

Paired Sample t-Test

The comparison means between healthy and WRD case for the lower peak is depicted in Table 2. The result indicates that, there is overwhelming evidence to assume that the healthy and WRD latex have significant difference between each other. It is proven by the mean significance of less than 0.05 (p-value<0.001). From observation of all tests, it can be concluded that healthy and WRD latex can be discriminated from each other. In addition, this information can be used as a reference for identification of white root infected rubber tree of dry rubber sheet using NIR measurement in the future.

Table 2: Paired Sample t-Test Sample

	Paired Differences							
	Mean	**Std. Dev**	**Std. Error**	**95% Confidence Interval of The Differences**		**t.**	**df.**	**Sig.(2-tailed)**
				Lower	**Upper**			
Pair: Healthy-WRD	0.0512	0.1301	0.0142	0.0229	0.0794	3.604	83	0.001

Conclusion

The NIR spectrum technique was applied in dry rubber sheet for determination of white root infected rubber tree. Results from optical measurement produced spectrum responses which are lower peak and upper peak. The shape patterns of both peaks might be similar for both healthy and WRD latex. The results from statistical analysis showed that, lower peak can be used in order to discriminate between both cases. It is proven by using normality test and parametric test. The error bar shows that there is a significant difference since the location of the plot is no overlapping between each other. The result from error bars reinforced by paired sample t-test has produced overwhelming evidence from each other. Therefore, the differentiation of healthy and WRD on dry rubber sheet using NIR technique was achieved at lower peak.

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