

# Study of Watermelon Sweetness Classification Based on Reflection Measurement

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**Abstract** This paper presents a study of watermelon sweetness classification with free space microwave measurement. The research goal is to investigate a feasible non-destructive method for watermelon sweetness classification based on the feature of reflection coefficient. We study from the scattering parameter for different sweetness of watermelon fruit by using network analyzer with free space method in the frequency range 0.8 to 3 GHz. After that the proper frequency was chose for analysis with linear regression. The experiment depicts good trend of relationship between reflection coefficient and sugar content (Brix ) which the sweet watermelon possess reflection coefficient less than 0.84. The apparent difference of reflection coefficient for sweet watermelon proposed the probability to design a watermelon quality classification system.

**Keyword** Sweetness Classification, Free Space Method, Reflection Measurement, Non-destructive Method

## 1. INTRODUCTION

Watermelon is a famous fruit with sugar content of the main characteristic and used for watermelon quality classification. Usually, the ripeness level of watermelon related sweetness. However, it is difficult to know the mature or sweet watermelon only by looking at its peel color. The current method for monitoring a watermelon is to sense sound by knocking that have to experience and use specialist. This means is sometimes inaccurate in determining the mature and sweet watermelon. Several studies [1]-[3] presented for determining the quality of watermelon based on non-destructive method such as acoustic impulse response, image color segmentation, near-infrared (NIR), etc. They are complex method. This work proposed a simple reflection measurement by using network analyzer that reflected signal estimation from a watermelon fruit. The experiment depicts apparent difference for the sweet watermelons.

## 2. PRINCIPLE

This work studies to determine the different sweetness of watermelon from the measured scattering parameter evaluation and also the correlation of immature and mature watermelons. The study process has two steps, the  $S_{11}$  parameter evaluation in a wide range of frequencies and the suitable frequency was chose from apparent difference of  $S_{11}$  for analyzing the relationship

between reflection coefficient and sugar content with linear regression.

The principle of a watermelon reflection measurement for analyzing sweetness used the reflected signal from RF oscillator that through a watermelon fruit. The space between watermelon and antenna is far-field region. The reflected power detection by using directional coupler and power detector is shown in Fig.1. Actually, these components are network analyzer and complex device as frame line.

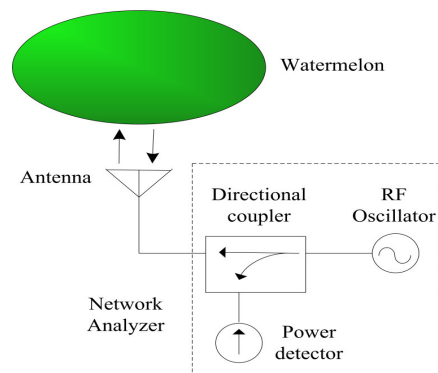


Fig.1. Diagram of the proposed reflection measurement.

## 3. RESULTS

A network analyzer (ROHDE & SCHWARZ ZVL 9kHz-6GHz) was used as both transmitter and receiver. A horn antenna (HA-08M18G-NF) was used for a watermelon measurement and connected network analyzer by using coaxial cable. The space from the horn antenna to a watermelon surface is 60 cm and high level from floor of watermelon is 120 cm as show in Fig.2. Variation of power signal is -10

dBm, 0 dBm and 10 dBm in the frequency range 0.8 to 3 GHz. The watermelon sample in the experiment is Kinnaree variety from general market amount 325 units. The sample size of 18 cm, diameter of 15 cm and weight of 2 kg on average were used.

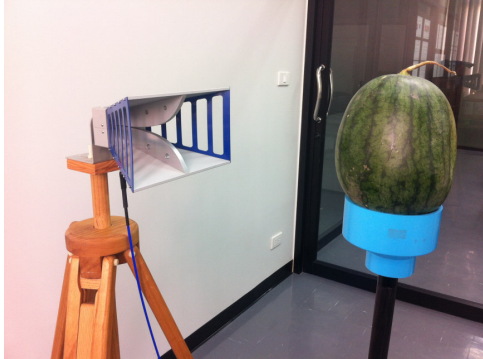


Fig.2. The experimental setup.

The reflection coefficient ( $\Gamma$ ) was calculated from the calibration by placing an aluminum plate on the fruit surface,  $\Gamma = P_{\text{measured}}/P_{\text{aluminum}}$ . The watermelon fruits were crushed for juice measurement of sugar content (Brix) by using OPTIK handheld refractometer B-32. We found that apparent difference in reflection coefficient at 2.0 GHz that correlates sugar content. The magnitude and phase of reflection coefficient versus Brix are shown in Fig.3.

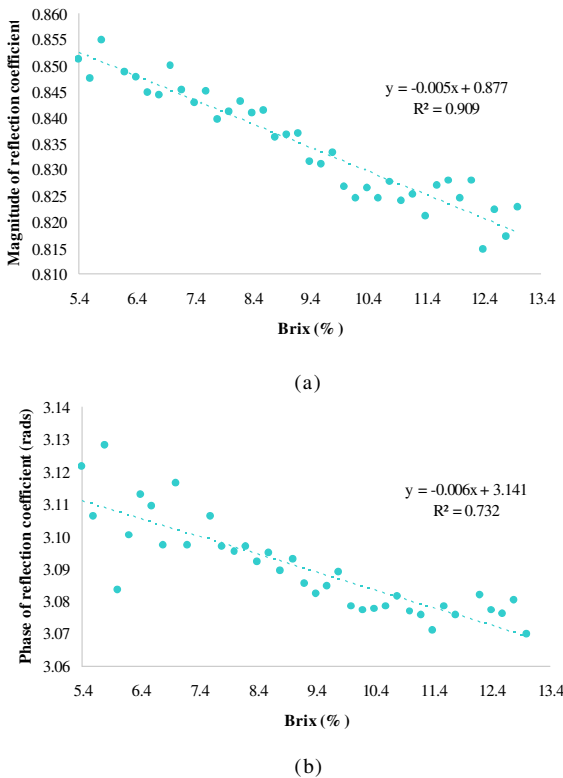


Fig.3. Reflection coefficient versus Brix (a) magnitude (b) phase.

The watermelons were tasted by a participant to confirm the sweetness of watermelon fruits. We found that immature watermelon fruits with Brix of 5.4-8% were slightly sweet. The mature watermelon with Brix more than 8% had a sweet taste.

Comparison of the correlation coefficient ( $R^2$ ) between magnitude and phase of reflection coefficient and Brix are 0.909 and 0.732, respectively. The  $R^2$  of reflection coefficient magnitude and Brix is better reflection coefficient phase and Brix.

According to OPTIK handheld refractometer B-32, watermelons with a Brix 8% are sweet. Hence, the value was chose as a threshold for classification of sweet watermelon and the reflection coefficient magnitude less than 0.84 that corresponds with watermelons at Brix  $\geq 8\%$ .

#### 4. CONCLUSION

This paper has studied the watermelon sweetness determination by a non-destructive method from reflected signal measurement of a watermelon fruit. The proposed a simple watermelon reflection measurement for determining watermelons sweetness has been investigated with apparatus and taste. An apparent difference in reflection coefficient for sweet watermelon depicted the probability to design a watermelon sweetness classification system.

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