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ORIGINAL ARTICLE

Designing and Creating Acoustic Ripeness Tester and Experimental Testing on Juan Canary Melon

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Musthofa Lutfi, Chakra Herlaut, Wahyunanto Agung N: Designing and Creating Acoustic Ripeness Tester and Experimental Testing on Juan Canary Melon.

ABSTRACT

Nowadays many methods have been developed for non-destructive sorting system such as detecting aroma and fruit color but those methods was rarely used in the society because of the lack knowledge of people how to use those tools. Hence another method for non-destructive sorting system being developed by created a tool that using an alternative approach which are by giving a knock on the fruit skin and determining the ripeness of one fruit based on the sound frequency from the knocking. The fruit that used on this research was Juan Canary melon with an assumption that fruits from the *Cucurbitacea* family have a special characteristic on their skin, which the skin will get harder or softer when it comes to ripe. The aim of this research are to explain the theory of fruit ripe assessment by knocking on the fruit skin, created a simple tool that can be used to determining a fruit ripeness without injuring the fruit by using the knocking method on the fruit skin and to know the range of sound frequency from the fruit knocking on each harvesting age.

From the tool test result that have been created, it was proved that the Juan Canary melon skin are going softer when its come to ripe, which is represented by the decreased value of the sound frequency. The sound frequency range from each harvesting age are 4.00 - 4.49 kHz for harvesting at 55th day; 2.38 - 2.91 kHz for harvesting at 60th day; 1.62 - 1.78 kHz for harvesting at 65th day; 1.61 - 1.62 kHz for harvesting at 70th day and 0.94 - 1.05 kHz for harvesting at 75th day. The sound frequency can be used to determining the quality (brix) of Juan Canary melon, the value of brix form the test was increasing day by day, thus make the relation between sound frequency and brix value was inversely proportional.

Key words: Ripeness, sound frequency, Juan Canary melon, mechanical plunger.

Introduction

Juan Canary melons are another type of melon that is primarily grown in hot, dry climates. Juan Canary melons are sold in the United States as a specialty item. The fruit are attractive with a smooth rind becoming golden yellow as the fruit ripen. Fruit are harvested prior to slip stage and can be difficult to determine when ready for harvest. The interior flesh is firm, and is usually light green or white sometimes with a hint of orange near the cavity of the fruit (Schulteis, J.R., 2002).

Many workers have worked in topics related to maturity and quality indices of fruits and vegetables. Most of them are of a chemical or physiological nature, and their determination requires laborious laboratory techniques. Nowadays nondestructive techniques for quality evaluation have also gained momentum. The nondestructive techniques particularly for fruits and vegetables are quick and very useful. Many physical characteristics of various fruits and vegetables have been determined nondestructively. But development of this technique needs certain engineering properties related to the methods to be used (Jha, S.N., 2002).

Consumers are interested in the period of optimum ripeness for edibility of melons as they continue to ripen even after harvest. However, melons exhibit various degrees of ripeness in a market; thus, making it difficult for consumers to assess the optimum ripeness for eating. The fact that melons loose firmness in postharvest ripening (Taniwaki, Mitsuru, 2009).

Some promising dynamic methods for fruit quality evaluation are based on measurement of fruit response to forced vibration. For example, Affeldt and Abbott, Van Woensel, *et al*., (Affeldt, Jr., 1989) and others found good correlation between the resonant frequencies derived from vibration tests and the mechanical properties of fruits. Armstrong, *et al.*, (Armstrong, P., 1990) caused mechanical impulse by striking an apple with a ball of

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wax. Young's modulus, which was calculated from the acoustic response, had good correlation with the measurement in compression tests of specimens taken from the same fruit. Poor correlation was found with the results of a standard M-T test. Chen and Sun (Chen, P. and Z. Sun, 1991) reported good correlation of the first two resonance frequencies between acoustic sensing and human auditory sensing. In their experiments, several apple varieties were struck mechanically while fruit response was detected by a microphone. They did not find significant differences among sound signals obtained at different locations around the fruit. Chen and De Baerdemacker (Chen, H. and J.D., De Baerdemacker, 1993) tested apples and concluded that the acoustic impulse response method appeared to be more efficient and accurate than random vibration methods (Wang, Jun., 2004).

The objective aim of this research are to explain the theory of fruit ripe assessment by knocking on the fruit skin, created a simple tool that can be used to determining a fruit ripeness without injuring the fruit by using the knocking method on the fruit skin and to know the range of sound frequency from the fruit knocking on each harvesting age.

Materials and Methods

2.1 Materials:

The materials that used to create the acoustic ripeness tester was iron plate, wire thread, iron cylinder, nylon cylinder, spring and sponge. And the Juan Canary melons were taken from one greenhouse with various harvesting age.

The equipment that used for completing the acoustic ripeness tester was microphone, computer and the software called Frequency Analyzer to measure the sound frequency.

2.2 Experimental Configuration:

Some adjustment for the acoustic ripeness tester was done before doing the experiment, such as setting the Frequency Analyzer by the default setting (16 bits per sample, 10 FFT's per seconds, 11025 sampling frequency, 1024 points per transform and choosing mike as source. For the mechanical plunger itself was done by positioning the plunger rod in a parallel lines with the directing track.

2.3 Experimental Procedure:

The Juan Canary melon inserted in the testing room, some adjustment was done for this step, such as placing sponge, determining the middle point of fruit and placing the microphone 100 mm from the knocking point. After that the Frequency Analyzer have to started with default configuration and then proceed to knocking the melons 5 times. The result that could be seen on the Frequency Analyzer interface was captured by doing print screen and zoomed to determine the exact peak point frequency from each knocking.

2.4 Experimental Conditions:

Several adjustments have been made for this experiment, Fruit term is one of them, for this research the Juan Canary melons were taken from a special greenhouse at Nongkojajar. Melons was protected from the outside and well treated in the greenhouse. The melons harvested in five various harvesting age with five day interval for each harvesting age and started from the 55^{th} day for the harvesting age. Five melons were taken for each harvesting age and the mass of every melon that used in this research were same for each harvesting age.

The place to test the acoustic ripeness tester was at Agricultural Power and Machinery Laboratory of Brawijaya University. The place was chosen because the place was quiet and had no nuisance noise that could prevent an error while measuring the sound frequency.

Parameters that have been evaluated on this research were sound frequency from the knocking process, fruit water content and brix value (sweetness index) of the fruit.

Result and Discussion

3.1. Acoustic Ripeness Tester:

The acoustic ripeness tester that has been designed was divided into three main parts, which are mechanical plunger, microphone and computer. Mechanical plunger function is to give an impact knocking to the fruit surface by a constant force, as for microphone used to convert the sound waves into a signal in a electrical

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voltage, and the computer here has been used as a super fast voltmeter that can be used to measure the sound frequency with using Frequency Analyzer software.

The mechanical plunger itself was consisted of main frame, plunger and barrier. The fruit was placed in the fruit ring at the main frame and plunger will be set in the plunger track of main frame. As for the barrier was placed to covered the fruit ring area to prevent an error that could be happen because the noise while measuring the sound frequency.

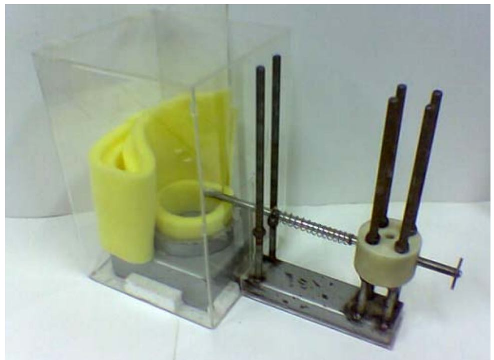

Fig. 1: Mechanical plunger.

3.2 Juan Canary Melon Knocked Sound Frequency At Various Harvesting Age:

The acoustic ripeness tester that have been created was used in this research to measure sound frequency from the knocking process, melons was harvested at 5 different harvesting age (55th day; 60th day; 65th day; 70th day and 75th day).

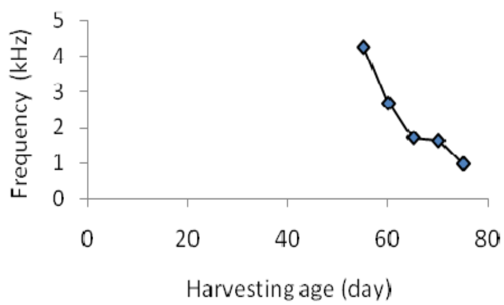

Fig. 2: Relation between harvesting age and sound frequency.

From the Fig. 2 it seen that the sound frequency was decreased when the fruit was come to ripe. The decreased value of sound frequency has happened because the fruit skin softened, melons skin become soft stage by stage after the ripening process because of the wall cell degradation that cause the adhesive cell at skin decreased.

According to the gardener from the greenhouse, Juan Canary melons usually harvested at 70th and 75th day, thus make the sound frequency range of ripe melons were at 0.9 – 1.6 kHz and the range of unripe melons were at 1.7- 4 kHz.

3.3 Water Content of Juan Canary Melons:

Water content of Juan Canary melons were evaluated to know the water content effect on measured sound frequency.

As seen at Fig. 3; the water content was constant at 55th day until 65th day. But it becomes decreased significantly at 70th and 75th day. Thus, made the relation between fruit water content and measured sound frequency not strong enough or with another word the fruit water content has not much effect on measured sound frequency.

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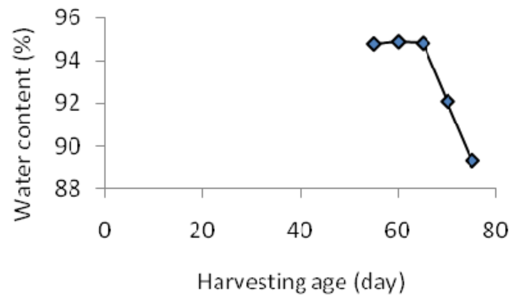

Fig. 3: Relation between harvesting age and water content.

3.4. Using Acoustic Ripeness Tester for Predicting Juan Canary Melons Quality:

After predicting the harvesting age, the sound frequency was used to predicting the quality of Juan Canary melons. Each melons at each harvesting age was evaluated by brix value which represent the sweetness index of the fruit.

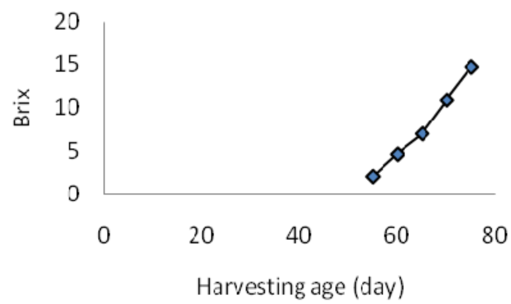

Fig. 4: Relation between harvesting age and brix value.

The result was obvious, the sweetness index value that has been measured was increased day by day and the increasing value of sweetness index was constant for each harvesting day.

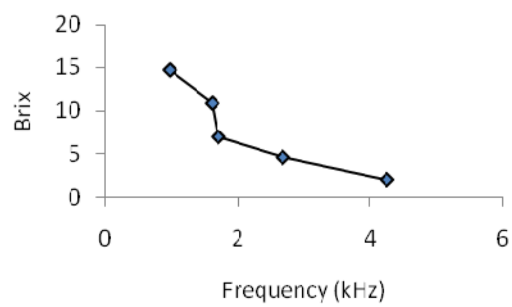

Fig. 5: Relation between sound frequency and brix value.

The sound frequency apparently could be used to predicting the quality of Juan Canary melons, as for seen at Fig. 5; the sound frequency will decrease as the sweetness index value increased. Thus, made the relation between the measured frequently sound was inversely proportional to the sweetness index value.

From these result it was simply to be said that the acoustic ripeness tester could be used to predicting the harvesting age and the quality of Juan Canary melons.

Conclusion:

The result from each parameter that have been evaluated showed that the acoustic ripeness tester could be used to predicting the harvesting age of Juan Canary melon and also could be used to predicting the sweetness index of Juan Canary melon. The more sweet

The acoustic ripeness tester set could be divided into three main parts, which are mechanical plunger as the knocker tools, microphone as the sound waves converter and computer as the processor to measure the sound frequency.

The sound frequency range for each harvest age were 4-4.49 kHz at 55th day; 2.38-2.91 kHz at 60th day; 1.62-1.78 kHz at 65th day; 1.61-1.62 kHz at 70th day; and 0.94-1.05 kHz at 75th day.

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