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Ultrasonic Evaluation of Indonesian Mango Fruits: an Initial Study

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1. Introduction

Indonesia is blessed with abundant-easily growing tropical fruits due to its location around the equator and its fertile soil. Mango is one of the most popular fruit in Indonesia, which is also considerably consumed all over the world. According to a report published by Food and Fertilizer Technology Center for Asian and Facific Region, the fruit is no. 4th in terms of production and also no. 4th the most exported fruit in Indonesia.[1] Despite those facts, inspection of the fruit still heavily relies on subjective-human perception. It is then compelling to study the possibility of using a more objective technology-based method as an alternative.

Ultrasonic wave has been used to inspect fruits nondestructively, owing to its capability to probe inside the thickness of the fruits. It is used to examine the relative water content and firmness of navel oranges.[2] Another group used surface elastic wave to evaluate the firmness of water melon. They observed a well correlation between the wave's velocity with the sensory firmness.[3]

The final goal of this study is to develop a nondestructive ultrasonic-based system to inspect the quality of a whole mango fruit. The most important quality parameter is ripeness, which can be indicated either as the sugar content (more ripe fruit contains more of it) or oppositely, the acidity level. It is also desirable that the method is able to figure out the size of fruit's seed. This initial study aims to investigate the influence of ripeness to the traveling velocity of the wave. The ripeness here is translated as sugar content, indicated as the percentage Brix or commonly known as °Brix.

2. Measurement Method

2.1 Mango fruit

A mango fruit is constructed of the fruit's flesh surrounding a single seed, which is then covered by a thin skin. Size of the seed relative to the whole fruit is diverse for a different variant. In some variants of mango, ripeness level can be distinguished easily from the skin color; usually a more ripe fruit has a brighter-looking skin color. Although, with certain trick, that color can be achieved even though the fruit is not yet ripe, making ripeness determination by visual inspection can be tricky. In most of Indonesian mangoes though, the skin color does not change so much as the fruit is ripening. In this case, ripeness can be predicted either by smelling of by pressing the surface; the softer the surface, the ripe the fruit. Although in some situation, the surface can be soft while the fruit is still unripe. Depending on the variant, the fruit flesh generally has a white-to-green color when it is young, and gradually changes into yellowish or reddish as it is ripening. Despite all those variations, a ripe fruit will certainly sweeter than the unripe counterpart.

2.2 Measurement Setup

To examine how sugar content affects the traveling velocity, several samples of mango fruit's flesh were prepared. The fleshes were taken from mangoes with various sugar contents. Ultrasonic wave was then propagated inside the fleshes in a through-transmission measurement method with a setup shown in **Fig. 1**. Sugar content of each sample was also measured by using a hand-held refractometer Master-500 from Atago, which is capable of measuring Brix level 0.0 to 90.0%.

The pulser-receiver machine drives the transmitter (T) which produces ultrasonic wave with center frequency of 60 kHz according to the maker. The wave is then transmitted into the fruit's flesh and picked up by the receiver (R). The received signal is sent back to the machine for signal processing. The received waveform is displayed by the oscilloscope, which can also be transferred to a USB flash memory.

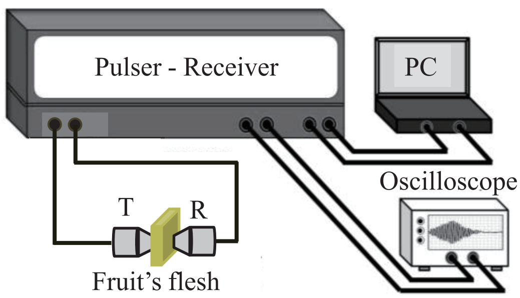

Fig. 1 Measurement setup

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3. Results and Discussion

Figure 2 shows the typical received signals for young and ripe mangoes with percentage Brix of 7 and 17, respectively. From the figure, we can see that the amplitude is smaller in the ripe than in the young fruit when compared to each driving signal. However, since amplitude is highly dependent on the contact pressure, the amplitude data cannot be not used as reliable evidences in the current measurement setup. Traveling time should be a better parameter for the current case, which can be used to find the traveling velocity. The velocity was determined by measuring arrival time of the first peak of each signal, indicated in the inset of **Fig. 2**. Thickness of the sample was measured by using a vernier caliper with resolution of 0.05 mm.

Figure 3 presents the observed traveling velocity of ultrasonic wave at 60 kHz as a function of sugar content indicated as percentage Brix. The descending trend can be seen clearly from the graph; the velocity decreases as the percentage of Brix increases. This finding indicates that the more ripe the fruit, the slower the velocity. Published works on the effect of ripening during storage period for water melon[3] as well as avocado showed the similar trend.[4] By using only human perspective, the flesh of a young fruit is denser than that obtained from a ripe fruit, therefore it can be expected that sound wave propagates faster in a young fruit. More study is necessary to get a better understanding of this result; however it can serve as a proof that ultrasonic velocity measurement can be a promising tool to evaluate the ripeness of mango fruit.

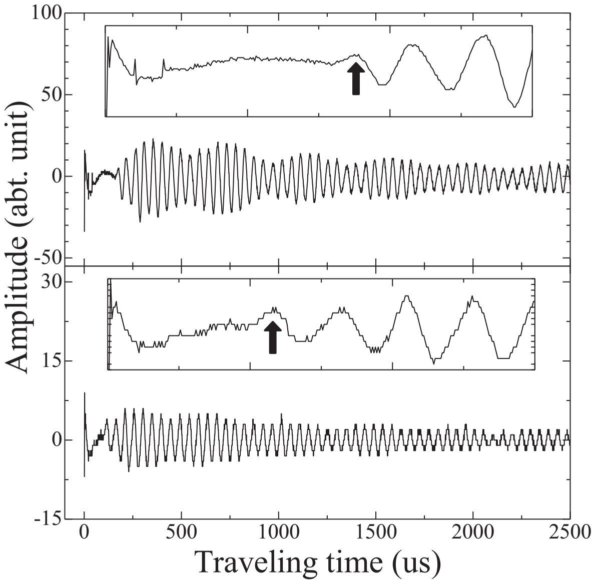

Fig. 2 Typical received signals of the wave propagating in a young (a) and a ripe (b) mangoes

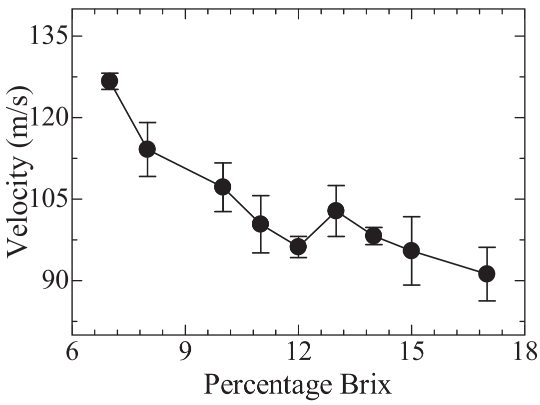

Fig. 3 Observed velocities of ultrasonic wave traveling in mango fruit's fleshes of various percentage of Brix level

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References

1. M.I. Rafani: Food & Fertilizer Tech. Cent. (2015)
2. D.S. Morrison and U.R. Abeyratne: J. Food Eng. **141** (2014) 107.
3. T. Ikeda, P.K. Choi, T. Ishii, I. Arai and M. Osawa: J. Food Eng. **160** (2015) 28.
4. G.K. Self, E. Ordozgoiti, M.J.W. Povey and H. Wainwright: Postharvest Biol. Tec. **4** (1994) 111.