



Design and Fabrication of a Watermelon Ripeness Tester Using Matlab Software GUI

V. C. Okafor^{1*}

¹*Department of Agricultural and Bioresources Engineering, Federal University of Technology, Owerri, Nigeria.*

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JERR/2020/v12i217077

Editor(s):

(1) Dr. P. Elangovan, Sreenivasa Institute of Technology and Management Studies, India.

Reviewers:

(1) Şükrü Kitiş, Kutahya Dumlupınar University, Turkey.

(2) Nataša Milosavljević, University of Belgrade, Serbia.

(3) Raheel Muzzammel, University of Lahore, Pakistan.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/56061>

Received 12 February 2020

Accepted 19 April 2020

Published 04 May 2020

Original Research Article

ABSTRACT

A non-destructive way to determine the ripeness of watermelon is very difficult, by outward characteristics such as size or external colour and used methods include different limitations. In this study a simple and intelligent method to determine the ripeness of watermelon was designed and developed by integrating a conventional method with electronics device, the ripeness of watermelon can be determined easily and reliable. Microphone was placed under the fruit sample to record a thumping signal. The recorded signals were converted into Fast Fourier Transform (FFT) waveform using MATLAB Software. The patterns of FFT waveforms were analysed using average magnitude at the frequency between 100 Hz and 4000 Hz to classify the ripeness. The average magnitude of was within the range of 0.00019 to 0.00030, and the magnitudes below 0.00025 were termed unripe and magnitudes above 0.00025 were termed ripe. Recommendations for further studies were stated.

Keywords: Non-destructive; ripeness; sound frequency; watermelon; GUI.

1. INTRODUCTION

Watermelon (*Citrulluslanatus*) belongs to the family *Cucurbitaceae* [1]. Its centre of origin has

been traced to both the Kalahari and Sahara deserts in Africa [2] and these areas have been regarded as point of diversification to other parts of the world. In Nigeria, though there are no

*Corresponding author: Email: okaforvictor14@gmail.com;

official figures recorded for its production, the crop has a wide distribution as a garden crop, while as a commercial vegetable production; its cultivation is confined to the drier savannah region of the Nigeria [3]. Watermelon is one of the world most important vegetables, as the crop is reared both for its fruit and the vegetative parts [1] which are highly nutritious.

Fruit ripeness is a complex concept that is very hard to quantify or even define. In fact, it is more a perception than an objective quantity. Many techniques have been devised to quantify such a perception [4].

Watermelon quality during consumption mainly depends on its extent of ripeness. Typically optimum quality watermelon fruit for eating have enough sugar, flavour, colour and texture. Judging Watermelon ripeness using its apparent properties such as size or skin colour is very difficult. The most common way by which people traditionally used to determine the watermelon ripeness is knocking it, and then judge the ripeness using the reflected sound. This method of using sound will create human factor errors; also it may only be a good way for people with much experience [5]. This idea led researchers to study acoustic methods to determine the watermelon ripeness. They received knocking sound using a microphone [6]. Acoustic measurements are based on the analysis of the natural resonance frequencies produced when the fruit surface is tapped. Practically there is no available measuring and sorting devices which can assess the ripeness of watermelon [7]. Various researchers have investigated non-destructive measurement of the internal quality of watermelons [8-11].

The increasing competition in domestic and international fruit markets is generating the need for improved ripeness evaluation techniques so that potential losses to the grower and packer, as well as fast spoilage at the consumer end, can be minimized. Although the determination of the optimal timing for harvest and the exact stage of ripeness are among the most important factors in the evaluation of quality in many fruit varieties, the need to find suitable techniques to monitor the ripeness state of a great amount of cultivars still exists [12]. Global production of watermelon in 2009-2010 was 99,194,223 metric tonnes and it is grown mostly in China and Turkey. As for Malaysia, the export market for watermelon is accounted for 1.55% of total world exports where Malaysia exported 50,643 tonnes of watermelon

which amounted to USD 17 Million in 2011 [7]. From that statistic it shows that watermelon is one of the best fruit in the world many people like it. However, it is not easy to determine the ripe and sweet watermelon in the market as the fruit has no odour and the texture cannot be seen internally. Although there are traditional methods to check for the watermelon ripeness but there are still not accurate and make consumer confused. Besides that, watermelon also does not ripen any further once it has been picked, so it is worth to select it carefully at the store. Whereas, just because a watermelon is ripe does not mean it will be perfectly sweet. Moreover, the consumer can avoid from wasting their money and being cheated by buying the rotten watermelon. Instead of consumer, the fruit sellers also facing the problem to pick the ripeness watermelon in the garden and with the supplier to make sure they sell the quality watermelon. Therefore, an intelligent watermelon ripeness determination system will be developed in this research. There are limited published documentations of recent studies on this subject matter. However, this study focuses on the design and fabrication of a watermelon ripeness indicator. When watermelon is hand-picked and graded based on the producer's experience and intuition, the quality is uncertain. To ensure sales of high quality watermelon, it is necessary to employ non-destructive quality detection and sorting based on the internal quality of the fruit.

2. MATERIALS AND METHODS

2.1 Material Description

Watermelon balls (Fig. 1) used in this research was harvested in Kano state Nigeria, and was procured from Obinze fruit market in Imo state, Nigeria. These fruits were harvested in Baragwa Village in Damaturu, Yobe State; Northern Nigeria. Twenty fruits were selected randomly, so as to have a random sampling. A microphone (Fig. 2) is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal. Microphones are used in many applications such as telephones, tape recorders, karaoke systems, hearing aids, motion picture production, live and recorded audio engineering.

Fast Fourier Transform (FFT) Waveform, which is a mathematical technique for converting a function of time into a function of frequency. Sometimes it is described as transforming from the time domain to the frequency domain. It is very useful for analysis of time-dependent

phenomena. Analysis of sound is one of the significant applications of Fast Fourier Transform (FFT). As the human ear has the limited hearing assess of frequency distribution of the power in sound is important. The FFT is analysed in MATLAB software which is seen on Graphical User Interface (GUI) on a computer's screen. MATLAB GUI is created using a tool called GUIDE, the GUI Development Environment. In this research, the MATLAB GUI is used to design the user interface for the system and make the system more users friendly. Examples of FFT in a GUI are seen in Figs. 3 and 4, whereas Fig. 5 shows the GUIs in a Matlab window.

2.2 Method

The experiment was conducted to identify the ripeness of watermelon. The signal gain from the microphone was analysed by an algorithm written with a Matlab software and shows the FFT waveform when the watermelon was thumped. The ripe and unripe watermelon was classified based on the pattern of FFT waveform and average magnitude. The result of ripe or unripe watermelon was displayed on a computer

using Matlab GUI. The experiment procedure is shown on the design block in Fig. 6.

2.2.1 Machine description

The components of the machine are:

- Microphone: It is a device that decodes the thumped watermelon sound and transmits to a computer system.
- GUI: It is the screen of the computer system where the received thumped sound waves are converted into graphs and figures. After the figures are gotten, there can be a final conclusion whether the watermelons being tested are ripe or not.
- The thump: This is an attachment on the machine use for thumping of the watermelon to get the sound wave which is then sent to the sound sensor. In this machine, the thump is wooden in nature with a paper cellotape attached to it (Fig. 7).
- The right and left clamp: This hold together or tightened the watermelon for it not to shake or move away its fixed position when thumping.



Fig. 1. Watermelon balls



Fig. 2. Test microphone

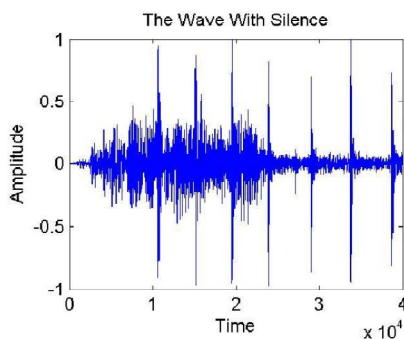


Fig. 3. The waveform spectrum

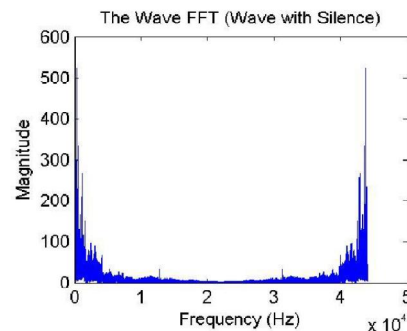


Fig. 4. The FFT waveform

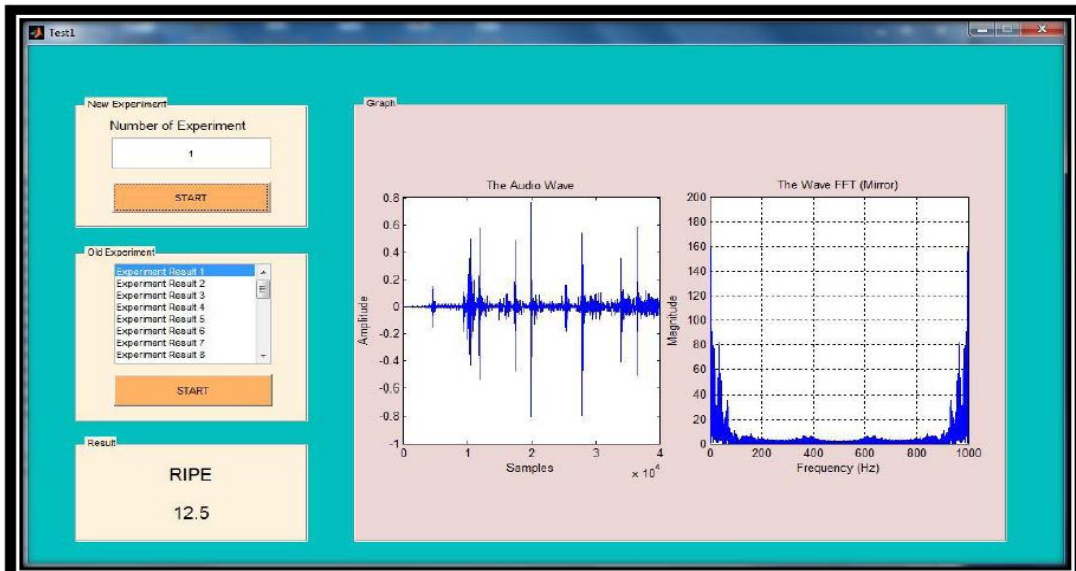


Fig. 5. FFT on a MATLAB graphical user interface (GUI) windows

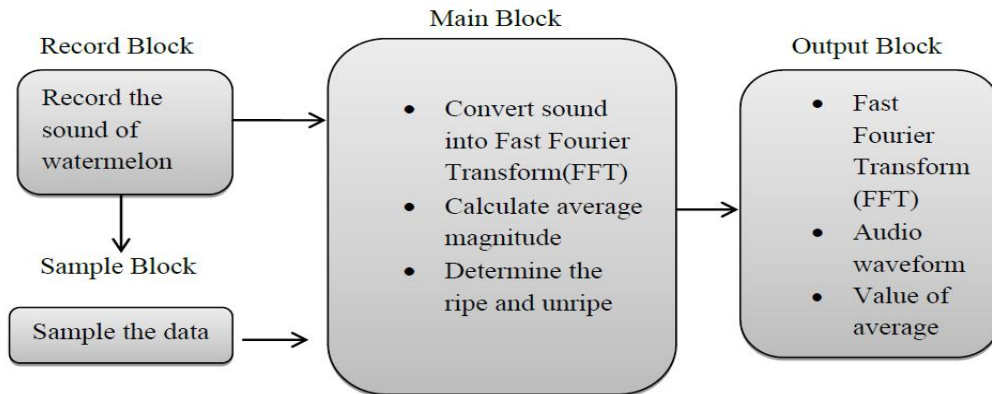


Fig. 6. Experimental flow chart

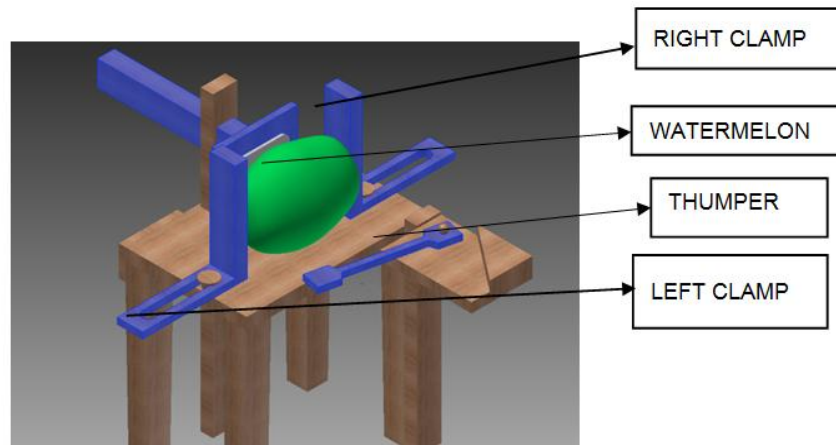


Fig. 7(a). Front view of the previous machine

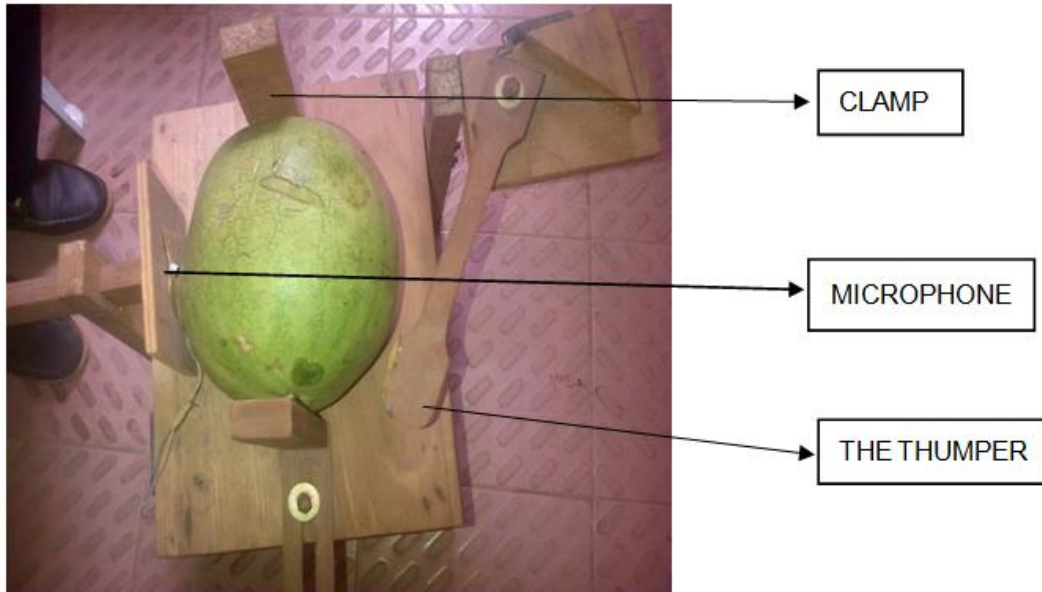


Fig. 7(b). Top view of the previous machine

3. RESULTS AND DISCUSSION

The tested samples gave a magnitude range from 0.00019637 and 0.00030793 as the test samples were cut open. The test results for the watermelon are presented as audio waveform and FFT waveform in a GUI as shown in Figs. 8 to 14. Fig. 8 shows the audio waveform and FFT waveform of watermelon of Experiment 1 with an average magnitude of 0.00021501. It is categorized as unripe since the magnitude is less than 0.00025. Fig. 9 shows the audio waveform and FFT waveform of watermelon of Experiment 2 with an average magnitude of 0.00029074. It is categorized as ripe since the magnitude is greater than 0.00025.

Fig. 10 shows the audio waveform and FFT waveform of watermelon of experiment 3 with an average magnitude of 0.00027942. It is categorized as ripe since the magnitude is greater than 0.00025.

Fig. 11 shows the Audio waveform and FFT waveform of watermelon of Experiment 4 with an average magnitude of 0.00026215. It is categorized as ripe since the magnitude is greater than 0.00025.

Fig. 12 shows the audio waveform and FFT waveform of watermelon of experiment 5 with an average magnitude of 0.00030793. It is

categorized as ripe since the magnitude is greater than 0.00025.

Fig. 13 shows the Audio waveform and FFT waveform of watermelon of experiment 6 with an average magnitude of 0.00019637. It is categorized as unripe since the magnitude is less than 0.00025.

Fig. 14 shows the audio waveform and FFT waveform of unripe watermelon of experiment 7 with an average magnitude of 0.00020717. It is categorized as unripe since the magnitude is less than 0.00025.

Fig. 15 shows the audio waveform and FFT waveform of unripe watermelon of experiment 8 with an average magnitude of 0.00023247. It is categorized as unripe since the magnitude is less than 0.00025.

Fig. 16 shows the audio waveform and FFT waveform of unripe watermelon of experiment 9 with an average magnitude of 0.00026748. It is categorized as ripe since the magnitude is greater than 0.00025.

Fig. 17 shows the Audio waveform and FFT waveform of unripe watermelon of experiment 10 with an average magnitude of 0.00024944. It is categorized as unripe since the magnitude is greater than 0.00025.

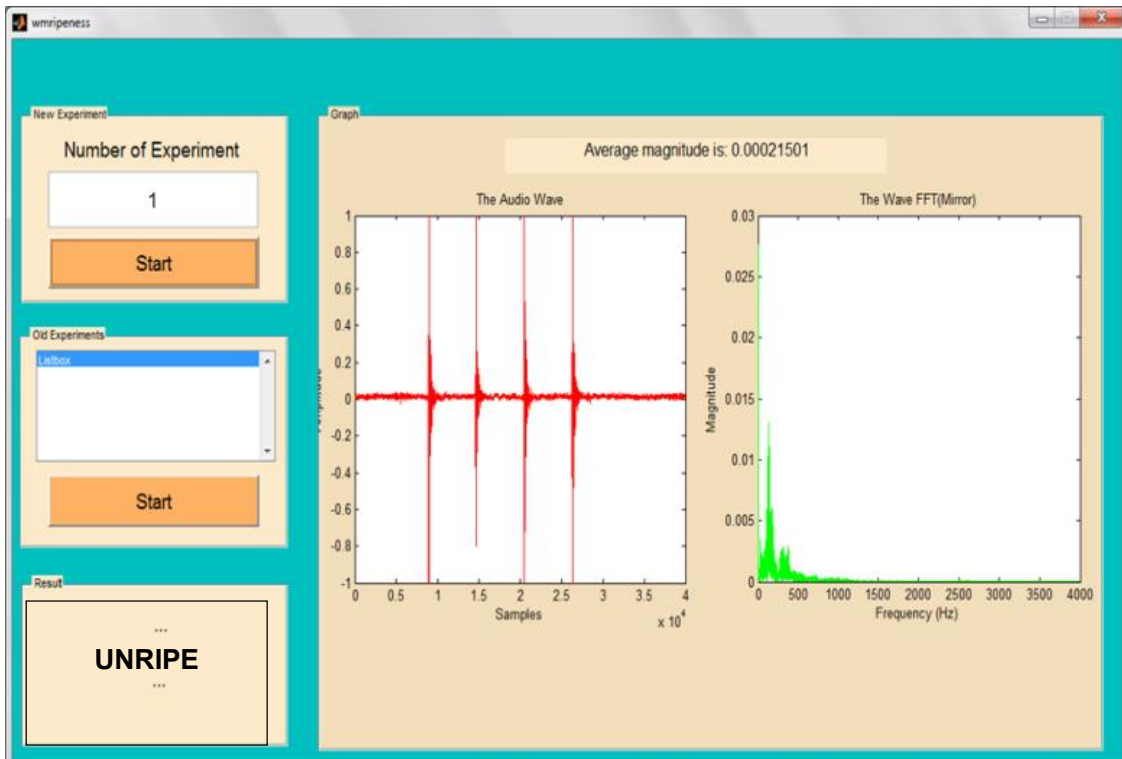


Fig. 8. Audio waveform and FFT waveform of unripe watermelon for experiment 1

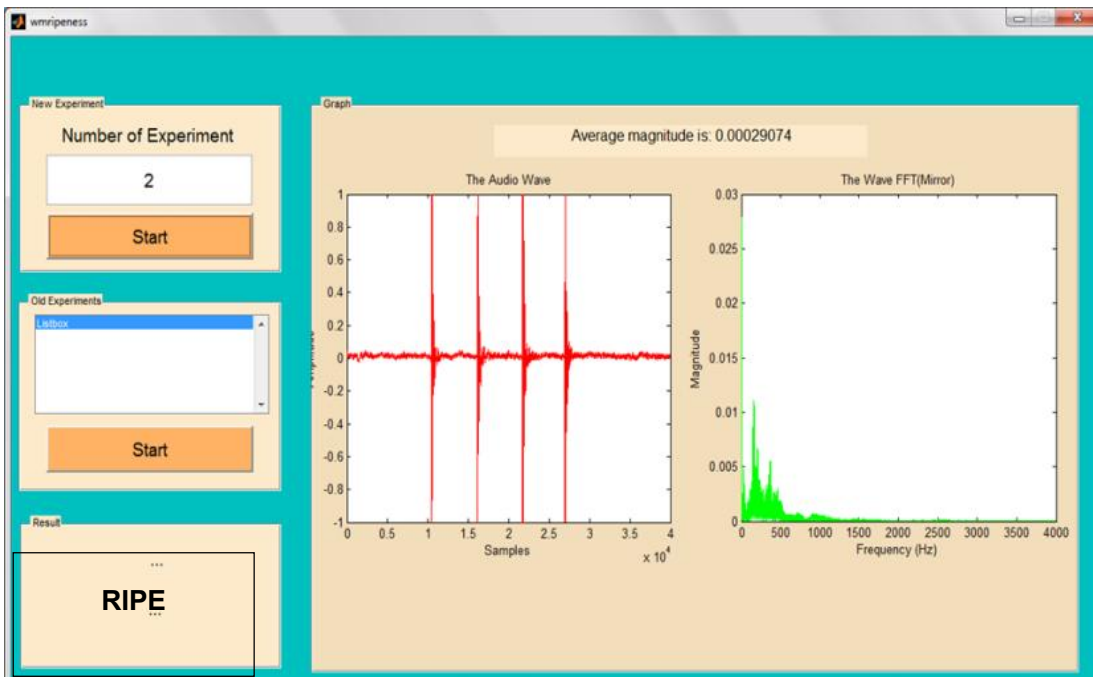


Fig. 9. Audio waveform and FFT waveform of ripe watermelon of experiment 2

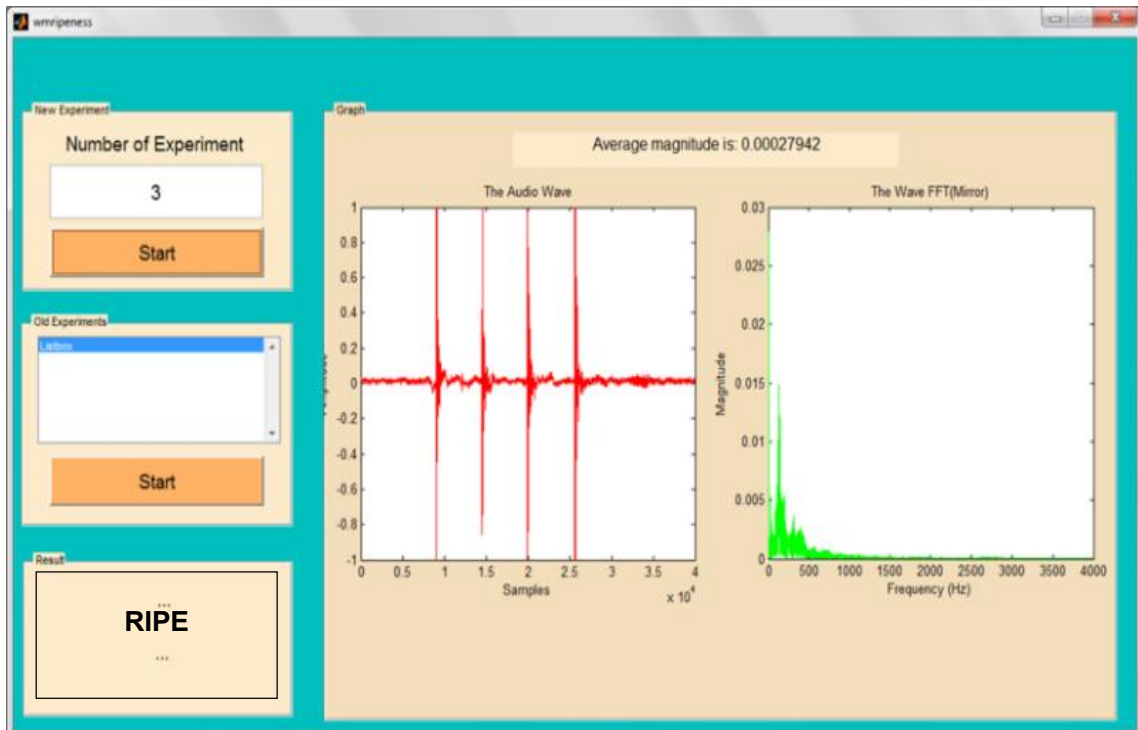


Fig. 10. Audio waveform and FFT waveform of ripe watermelon of experiment 3

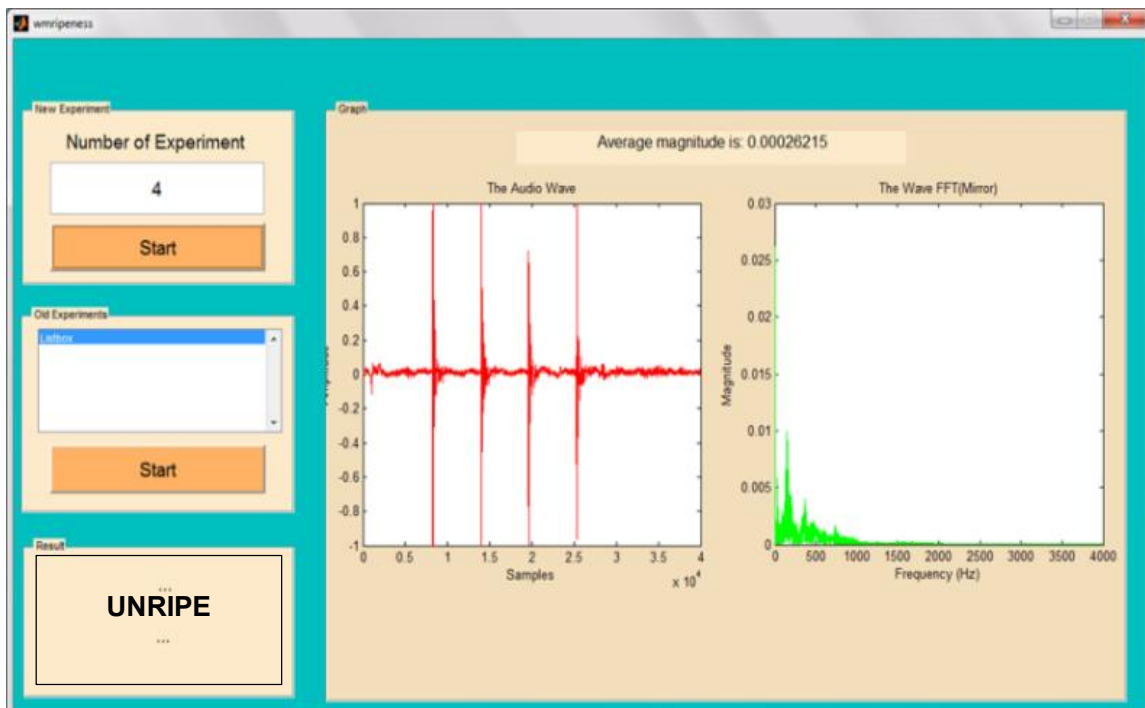


Fig. 11. Audio waveform and FFT waveform of unripe watermelon of experiment 4

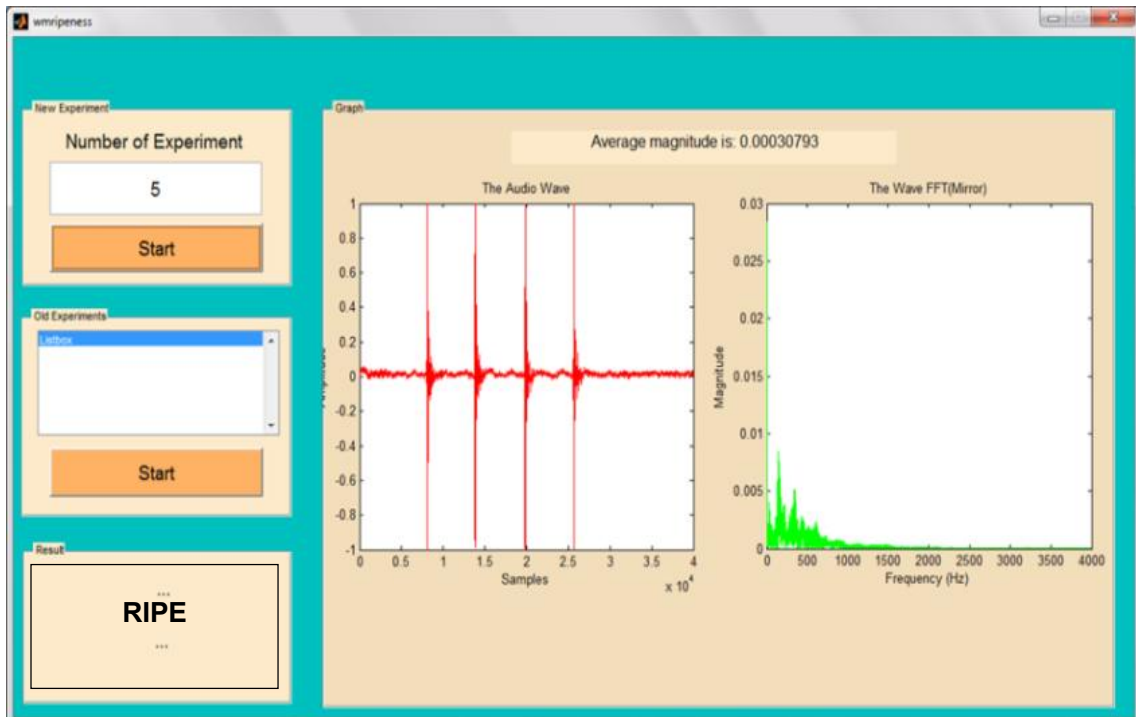


Fig. 12. Audio waveform and FFT waveform of ripe watermelon of experiment 5

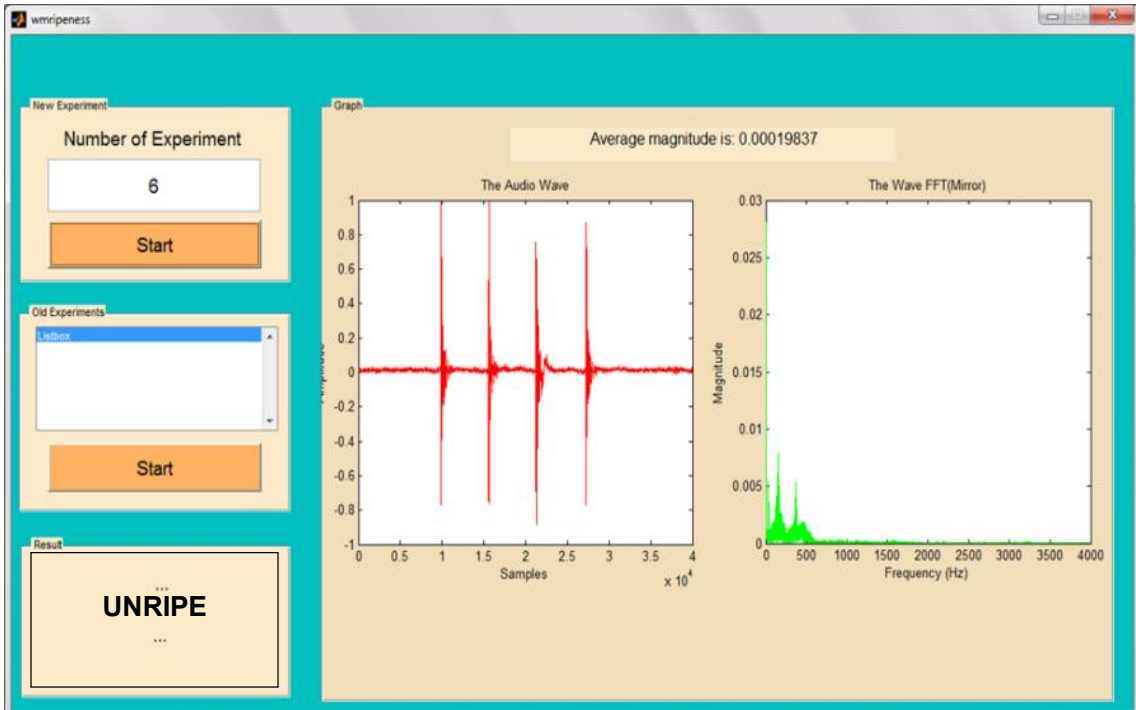


Fig. 13. Audio waveform and FFT waveform of unripe watermelon of experiment 6

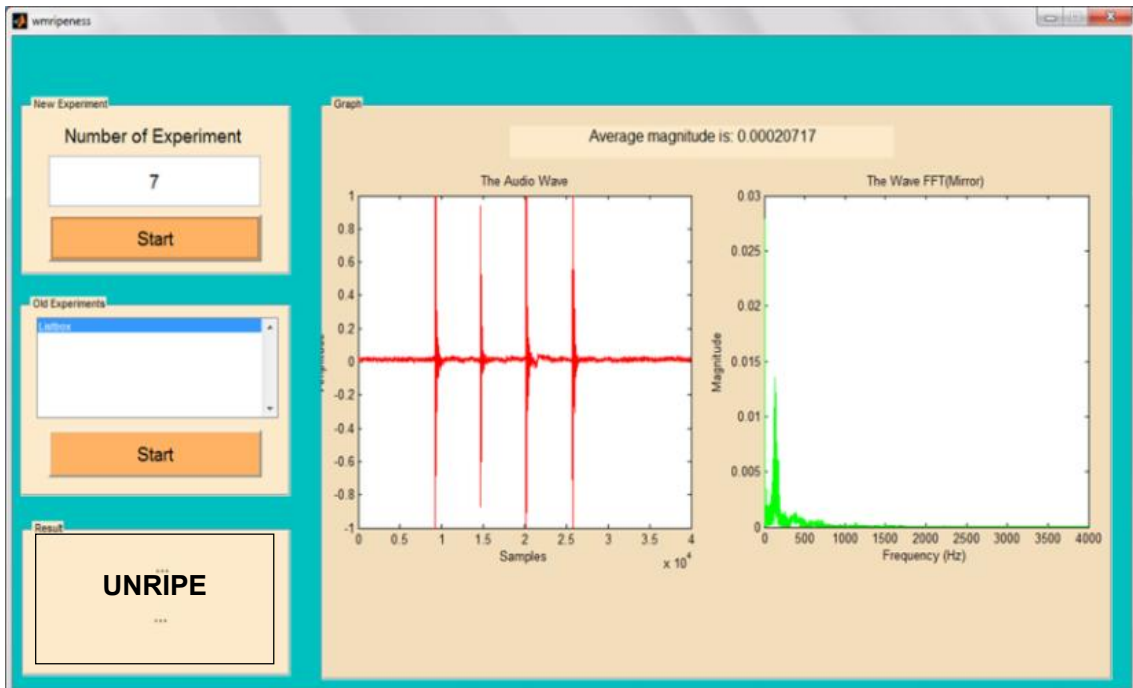


Fig. 14. Audio waveform and FFT waveform of unripe watermelon of experiment 7

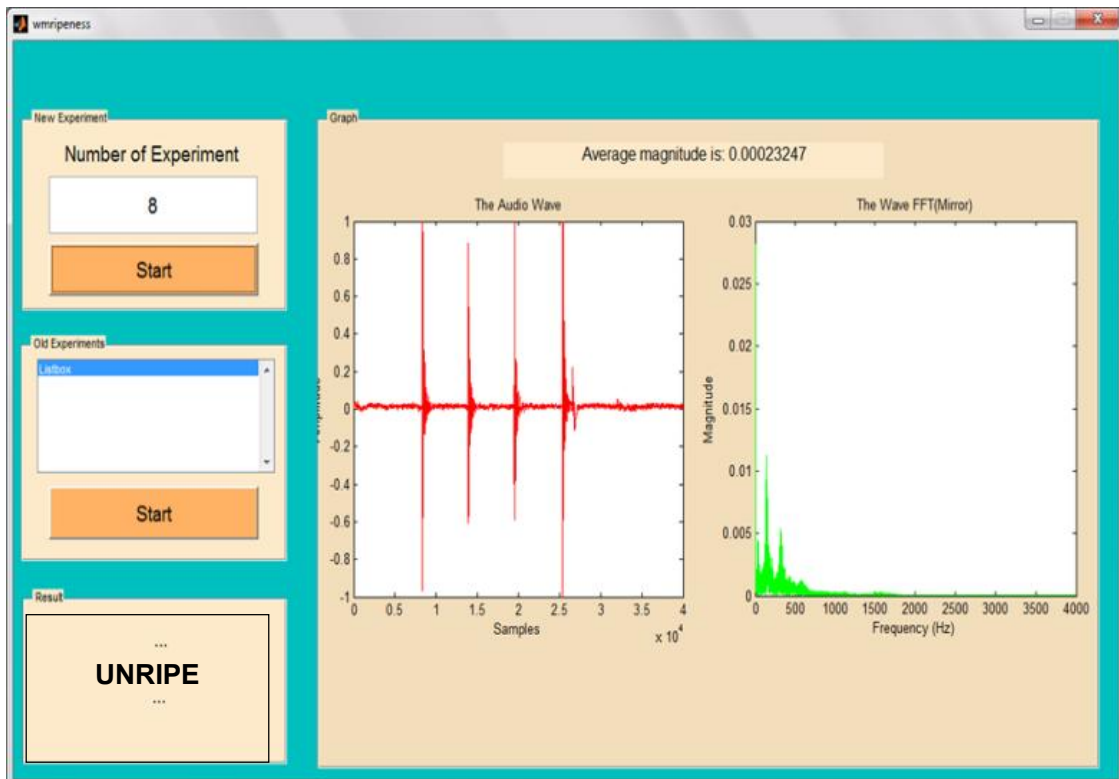


Fig. 15. Audio waveform and FFT waveform of unripe watermelon of experiment 8

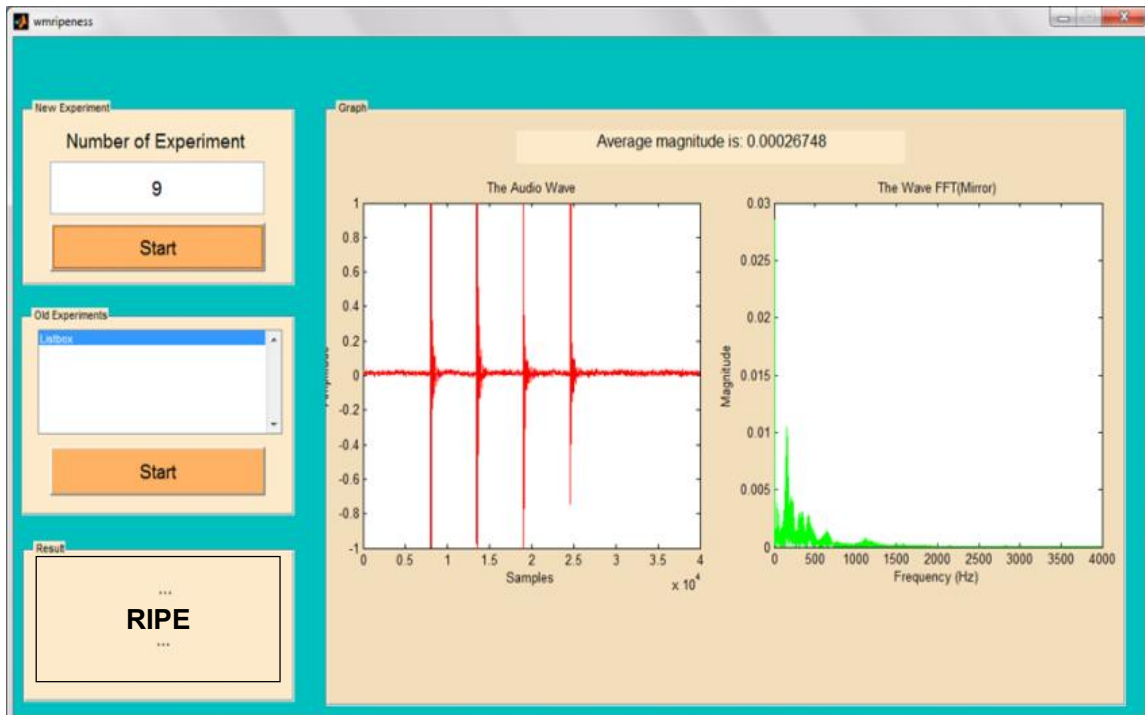


Fig. 16. Audio waveform and FFT waveform of unripe watermelon of experiment 9

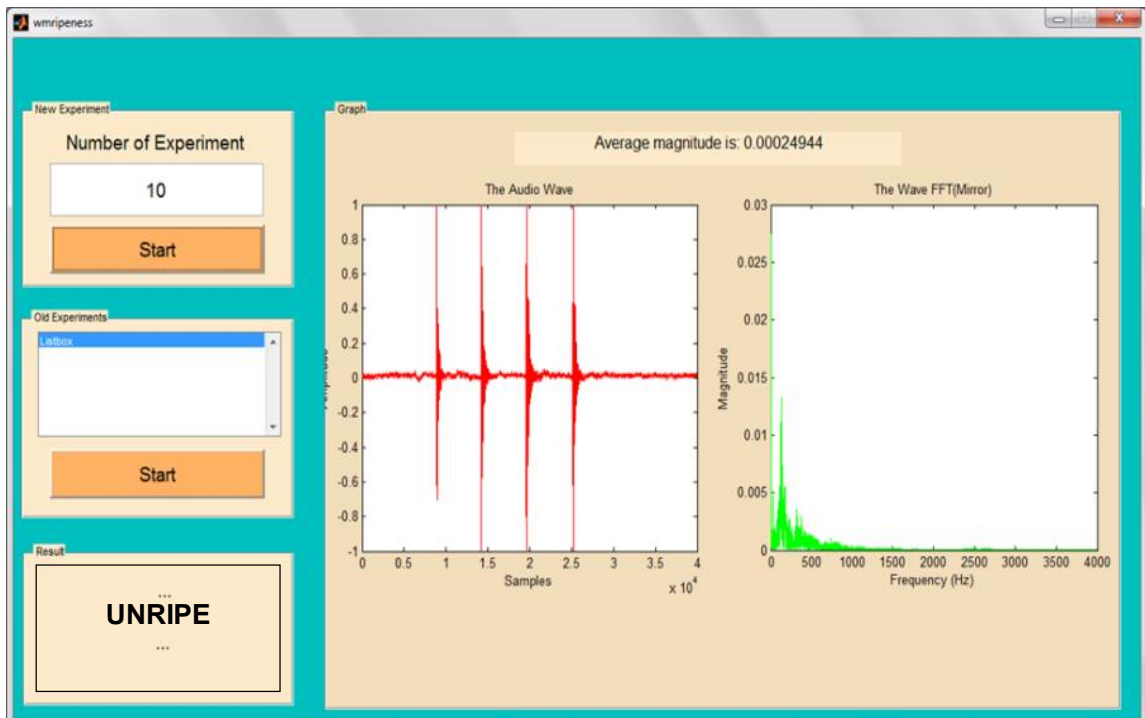


Fig. 17. Audio waveform and FFT waveform of unripe watermelon of experiment 10

These results were based on their average magnitudes and with frequency of 100 Hz to 4000 Hz. For most experimental results, the average magnitude of 0.00025 were termed unripe. Whereas the experiments with average magnitude of 0.00025 were termed ripe.

4. CONCLUSION

The design and fabrication of a watermelon ripening indicator was successful and its functionality were tested using watermelon fruits. And after the tests the watermelon were cut open to confirm that their state of ripeness or unripeness conform to the magnitude produced. The experiment gave the audio waveform and FFT waveform for each watermelon using Matlab software and GUI. The average magnitude of is within the range of 0.00019 to 0.00030, and the magnitudes below 0.00025 were termed unripe and magnitudes above 0.00025 were termed ripe.

With a chart developed from Fig. 6 to Fig. 15 a fruit seller will be able to separate between ripe and unripe watermelons, or can simply follow the steps of the experiment to achieve the magnitudes. This research will improve watermelon production when introduced to the public, since it is an efficient method of determining the ripeness of watermelons, and can be used at fruit shops instead of the traditional methods.

The objectives of this work have been achieved, which are to modify the previous machine; to test run the machine to get the accurate test results of the ripening of the watermelons using the Matlab software. This research serves as a beginning for the modification of the watermelon ripeness indicator. The following recommendations are hereby given for further research work:

- Developing the machine into portable device.
- By creating a smart phone application that can detect the ripening of watermelon using the microphone embedded in a smart phone.
- Design of an embedded system that can detect the ripening of watermelon, besides smart phone application is of considerable interest.

ACKNOWLEDGEMENT

I want to appreciate the efforts of Engr. Chinweuba Dennis in this work, also the technicians of Agricultural and Bioresources Engineering workshop in Federal University of Technology, Owerri Imo state, Nigeria.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Schippers RR. African indigenous vegetables. An overview of the species. Chatthan, UK. N.R/ACO. EU. 2000;56-60.
2. Jarret B, Bill R, Tom W, Garry A. Cucurbits germplasm report. Watermelon National Germplasm System, Agricultural Service, U.S.D.A. 1996;29-66.
3. Anons A. Nasarawa State Agricultural Development Programme, Annual Crop Area and Yield Survey (CAYS), Lafia, Nasarawa State. 2006;4-8.
4. Brezmes J, Fructuoso LL, Llobet E, Vilanova X, Recasens I, Orts J, Saiz G, Correig X. Evaluation of an Electronic Nose to Assess Fruit Ripeness. IEEE Sensors J. 2005;5(1):97-108.
5. Stone ML, Armstrong PR, Zhang X, Brusewitz GH, Chen DD. Watermelon maturity determination in the field using acoustic impulse impedance techniques. Trans. of the ASAE. 1996;39:2325–2330.
6. Xiuqin R, Yibin Y. Inspection of watermelon maturity by testing transmitting velocity of acoustic wave. Agric. Mech. in Asia, Africa and Latin America. 2006; 37(4):41-45.
7. Farah WB. Intelligent watermelon ripeness determination; 2014. Available:http://portal.fke.utm.my/fklibrary/files/farahwahidabintimdarepen/2014/809_FARAHWAHIDABINTIMDAREPEN2014.pdf (Accessed February 2020)
8. Chuma Y, Shiga T, Hikida Y. Vibrational and impact response properties of agricultural products for non-destructive evaluation of internal quality (Part I). J. Japan. Society of Agric. Mach. 1977; 39(3):335-341.

9. Yamamoto H, Haginuma S. Dynamic viscoelastic properties and acoustic properties of watermelons. Report of Nat. Food Res. Inst. 1984;44:30-35.
10. Sasao A. Impact response properties of watermelons in growth process. J. Japan. Society of Agric. Mach. 1985;7(3):355-358.
11. Kawamura T, Nishimura I. Studies on the physical property of watermelon (Part I J. Japan. Society of Agric. Mach. 1988;50(2): 85-92.
12. Sarig Y. Potential applications of artificial olfactory sensing for quality evaluation of fresh produce. J. Agric. Eng. Res. 2000; 77(3):239–258.

© 2020 Okafor; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/56061>