# Preliminary Studies on Non-Contact Measurement Technique in Agriculture Industry

Syazili Roslan, Mohd Hudzari Razali,
Kamarul 'Ain Mustafa and Aliah Fatin Abd Rasidadi
*Faculty of Bioresources and Food Industry,*
*Universiti Sultan Zainal Abidin,*
*22200, Besut, Terengganu, Malaysia.*
*mohdhudzari@unisza.edu.my*

***Abstract*— The PSA-T series (PSA1301T) is fully portable spectrum analyzer incorporating with a handheld computer which is a Palm T|X that is lightweight and small to be operated as a handheld instrument. Microwave spectrum analyzer is a kind of technique that allows a user such as farmer or agriculture producer to improve and manage their production especially to achieve high yield production. It functions as a rapid detection technique for measuring microwave reading which frequency of the potato (Solanum tuberosum) and followed by moisture content for potato. The potato is an underground tuber which is a same as Dioscorea hispida variety that also known as 'ubi gadong'. It is not easy to estimate the ripening stage of potato just by looking at their colour. The frequency of the potato that obtained by using the microwave spectrum analyzer were correlated with the moisture content of potato that was calculated by using the formula. The unripe, ripe and overripe potatoes were assumed by their physical appearance and colour. The microwave spectrum analyzer can be used to see the correlation between frequency and the moisture content. For unripe potato, the moisture content is 77.17% and the microwave reading was 551.4065 Hz. For ripe potato, the moisture content was 77.75% and the microwave reading was 794.15526 Hz. Besides that, the overripe potato had 83.87% of moisture content and 895.3125 Hz microwave reading. As the moisture content increase, the microwave reading (frequency) also increase. It will easier to agriculture producer to estimating ripening stage of potato and manages their produce well.**

***Index Terms*— Solanum tuberosum; Microwave spectrum analyzer; Frequency; Moisture content.**

## I. INTRODUCTION

This study was focused about the application of microwave as a rapid detection technique for measuring microwave reading which frequency of the potatoes and followed by moisture content (MC) for potato. The microwave application used was the PSA-T Series portable spectrum analyzer. Microwave is a kind of method and technique that allow a user such as farmer or agriculture producer to improve their production especially to achieve high yield production. Generally, the criteria for agriculture product's price is determine by it maturity stage by looking at their physical appearance like the colour. The maturity is related to MC while to determine MC of potato is required tedious and messy work at laboratory environment. This study is about to introduce new technique of microwave application to develop rapid detection technique for measuring MC of potato. This will be easier to know the maturity stage of potato and suitable for marketable prize in term of agricultural wholesaler. For instance, [7, 8, 3, 10] studied microwave moisture sensing method to estimate MC in hevea latex's product made, banana, watermelon, apple, cereal grain and granular materials, respectively. The performance and accuracy of MC measuring instruments is great importance in the storage, production, trade, and processing for most of crop products and natural raw materials [1]. Normally, the large suppliers and wholesalers of agricultural production need to face some problem when to get the source of potato due to the potato which is underground tuber that not easy to identify whether it is already ripe for sales or not.

The potato is an enlarged portion of an underground stolon or stem. The potato is an underground tuber that has fibrous root. The tuber are produced near the soil surface that stated by [2]. According to [2], the potato (Solanum tuberosum) (Figure 1.) which is from family Solanaceae is an underground stems. The potato is a tuber that has rich of starch content. The time of harvesting are varies depend on the consumer usage. As for wholesalers, they need to state about different price for different ripening stage of potato. The potatoes have high MC. During storage, it able to reach the equilibrium condition with the variable environment around them. Potatoes are grown essentially for two different consumption uses which are for fresh market and the potatoes with characteristics that allow them to be processed into fries or chips [2].

Figure 1: The potato (Solanum tuberosum)

The spectrum analyzer is the portable device that can be used to measure the composition of fruit, food, or agriculture product. The spectrum analyzer is necessary to establish the dielectric properties of particular sample that detected as a function of frequency and followed by the composition of the sample potato. According to [3], the dielectric measurement methods and equipment can be described for various frequency ranges starting from lowest frequency which is audio frequencies and followed by microwave frequencies. Based on the data get, it will be used to do the characterization of the specific agriculture product. Besides that, there are various microwave technique are developed including the temperature control apparatus to fully characterize agriculture produce [4]. But for this study, the spectrum analyzer which is PSA1301T series was chosen to determine the frequency of potatoes. This series is fully portable spectrum analyzer incorporating a handheld computer. The spectrum analyzer also is sufficiently small and lightweight to be operated as a handheld instrument.

## II. Materials and Method

### A. Materials

Potato (Solanum tuberosum), microwave spectrum analyzer (PSA-T Analyzer), analytical balance and oven.

### B. Methods

The potato (Solanum tuberosum) was chosen at the market based on the physical appearance like colour and the firmness that was assumed as overripe, unripe and ripe. The microwave spectrum analyzer was charged at least 4 hours before used. The microwave spectrum analyzer setting was adjusted. The start and stop frequency range could be set up. The start and stop range that suitable for potato is 500 MHz to 1 GHz (Figure 2). The probe was attached to the top portion of microwave spectrum analyzer (Figure 3). The probe was penetrated to the potato surface by randomly. The PSAnalyzer tool was chosen. Run the microwave. The highest peak was observed shown the frequency. Save and store the screenshot of peak in the memory card. The frequency of potato was taken (Figure 4). The potatoes were taken to the laboratory to the next procedure. The fresh weights of potatoes were weighed. The potatoes were put into the oven about 24 hours at temperature 1080C. Then, the potatoes were weighed again to get the dry weight to calculate the moisture content (Figure 5). The MC of potatoes was calculated by using Equation (1) below:

$$Moisture\,content\,(MC)(\%) = \frac{fresh\,weight - dry\,weight}{Fresh\,weight} x100 \quad (1)$$

After finished the experiment, the data obtained were recorded and analyzed by using graph to see the correlation. Flow chart of the process for the project: Figure 2. Setting the start and stop frequency range; Figure 3. The probe penetrated to the surface of potato; Figure 4. Run the microwave spectrum analyzer; Figure 5. The potatoes after proceed the dry weight process.

## III. Results and Discussion

### A. Measuring the microwave reading (frequency) of potatoes

The experiment was done for measuring the dielectric properties of potato product from 500 MHz to 1 GHz range. As we know, the potatoes are underground tuber that not easy to estimate their stage of ripening due to their colour more or less similar. It different from other type of fruit such chillies that we can identify their ripening as red for ripen and green for unripen. So, for this experiment the potatoes are prepared by using unripe, ripe, and overripe feature. The parameters that have been used were dielectric properties which are frequency and MC of potatoes. The relation between the reflection coefficient magnitude and MC in potato was investigated. There is variable type of peak that had been obtained from the experiment.

From Figure 6, the result which is 915.6250 MHz as a higher peak. This result is one of the examples of overripe potato sample.

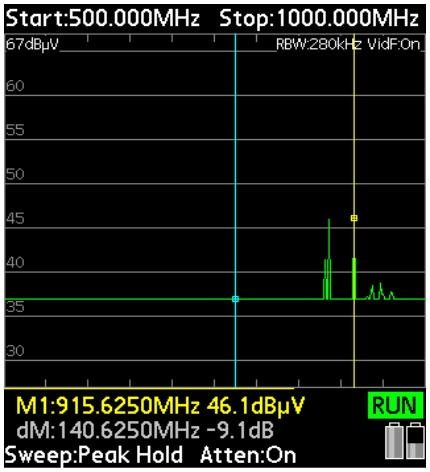


Figure 6: The result of overripe potato

For the sample of ripe potato, the result is in between the overripe and unripe potatoes, 631.2500 MHz. The peaks got were not high and not too low (Figure 7). The result for unripe potato is 592.1875 MHz (Figure 8).

For the first experiment, the microwave spectrum analyzer was run for 3 stages of potatoes; ripe, unripe and overripe. The detection to get reading of microwave spectrum analyzer was done about 5 times for each potato. The detection was done randomly at surface of the potatoes, not focused on one point only. Then, from 5 readings that were taken, the average was made. After done, the potatoes were brought to the laboratory to be weighed by using analytical balance. The fresh weight for potatoes was taken to calculate their MC. The potatoes were incubated in the oven for about 24 hours at $105^0$C.


Figure 7: The result of unripe potato


Figure 8: The result of ripe potato

### *B. Correlation*

Figure 9 shows the graph of first trial. The microwave result for unripe potato seems to not increase evenly. At the 67.7% of MC which is unripe potato, the microwave reading obtained was higher than the 72.4% and 76.95% of MC. It supposed to be at the 67.7% of MC, the microwave reading must lowest. It might be cause by some mistake or human error during handling the experiment. The MC for unripe potato is 67.7% and the average microwave reading is 574.375 Hz. For ripe potato, the MC is 72.4% and the average microwave reading is 553.75 Hz. The overripe potato had 76.95% of MC and also 553.75 Hz of microwave reading.

Both of Figure 10 and Figure 11, have shown the positive results. The graph for second trial was increasing steadily from unripe, ripe, and overripe. As the percentage of MC increase, the microwave reading or frequency also increase. For unripe potato, the MC is 77.17% and the microwave reading was 551.4065 Hz. For ripe potato, the MC was 77.75% and the microwave reading was 794.15526 Hz. Besides that, the overripe potato had 83.87% of MC and 895.3125 Hz microwave reading. Same goes to third trial which have 62.29% of MC for unripe potato and 645.87638 Hz microwave reading. For ripe potato, the MC was 76.92% and the microwave reading was 849.6875 Hz. Then, for overripe potato, the MC was 77.34% and microwave reading was 908.7499 Hz.

## IV. CONCLUSIONS

By the presence of rapid detection technique using spectrum analyzer, the agricultural producer in the future will be easy to manage the production of potato well. It is because of the MC and the ripening stage of potato will be known easier without need to go to the laboratory to do oven dry often. The agricultural producer just need to check with the graph and scale that obtained from this study. So it will save the time to do the checking of agriculture product before consumed it.

For entrepreneur, they need to consume the healthy and good quality of product to consumer. Besides that, they need to responsible towards their product by make sure the product not perishable. So, by use this equipment, they can get the ripening stage and MC more accurately compare to look by naked eyes and could save time. As we all know, the MC is one of properties of food materials that most commonly measured. It is important in term of the economical aspect which is the cost of many agricultural produce depends on the amount of water they contained. Besides that, in term of processing operations, knowledge of the MC is necessary to predict the behavior of agriculture produce during managing and processing especially the packaging. For potatoes that will have to export and need long time to reach the destination, this needs to care more. If the potatoes that consumed to the consumer still at under ripe stage and over ripe stage, it will affect the cost of sale. It is therefore important for agriculture producer to be able to reliably measure MC.

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## REFERENCES

[1] Hamad A., Ali, Abbas, Zulkifly, Hassan, Jumiah, Jusoh, Ashry, Mustapa Z., and Rahima, "Microwave Antenna Sensing Technique For Determination Of Moisture Content in Hevea Latex from Hevea Brasiliensis Tree," *Australian Journal of Crop Science*. vol. 5, no.11, pp. 1326-1333, 2011.

[2] Transport Information Service. Cargo Loss Prevention Information From German Marine Insurers of Potatoes. http://www.tis-gdv.de [15th October 2013], 2002.

[3] Nelson S. O., Guo W. C., Trabelsi S., and Kays S.J., "Dielectric Spectroscopy of Watermelons for Quality Sensing," *Measurement Science and Technology*, pp. 1887, 2007.

[4] Badaruzzaman M. N., "Application of Microwave Sensors to Potato Products," School Of Electrical and Electronic Engineering, 2010.

[5] Duprat F., Laser Light Based Machine Vision System for Non-Destructive Ripeness Sensing of Golden Apples. Paper presented at 1st workshop of control applications in postharvest and processing technology, CAPPT, 1995.

[6] Tapre A. R. and Jain R. K., "Study of Advanced Maturity Stages of Banana," *International Journal of Advanced Engineering Research and Studies*, vol. 1, no. 3, pp. 272-274, 2012.

[7] Trabelsi S. and Nelson S. O., "Unified Microwave Moisture Sensing Technique for Grain and Seed," *Measurement Science and Technology*, 2007.

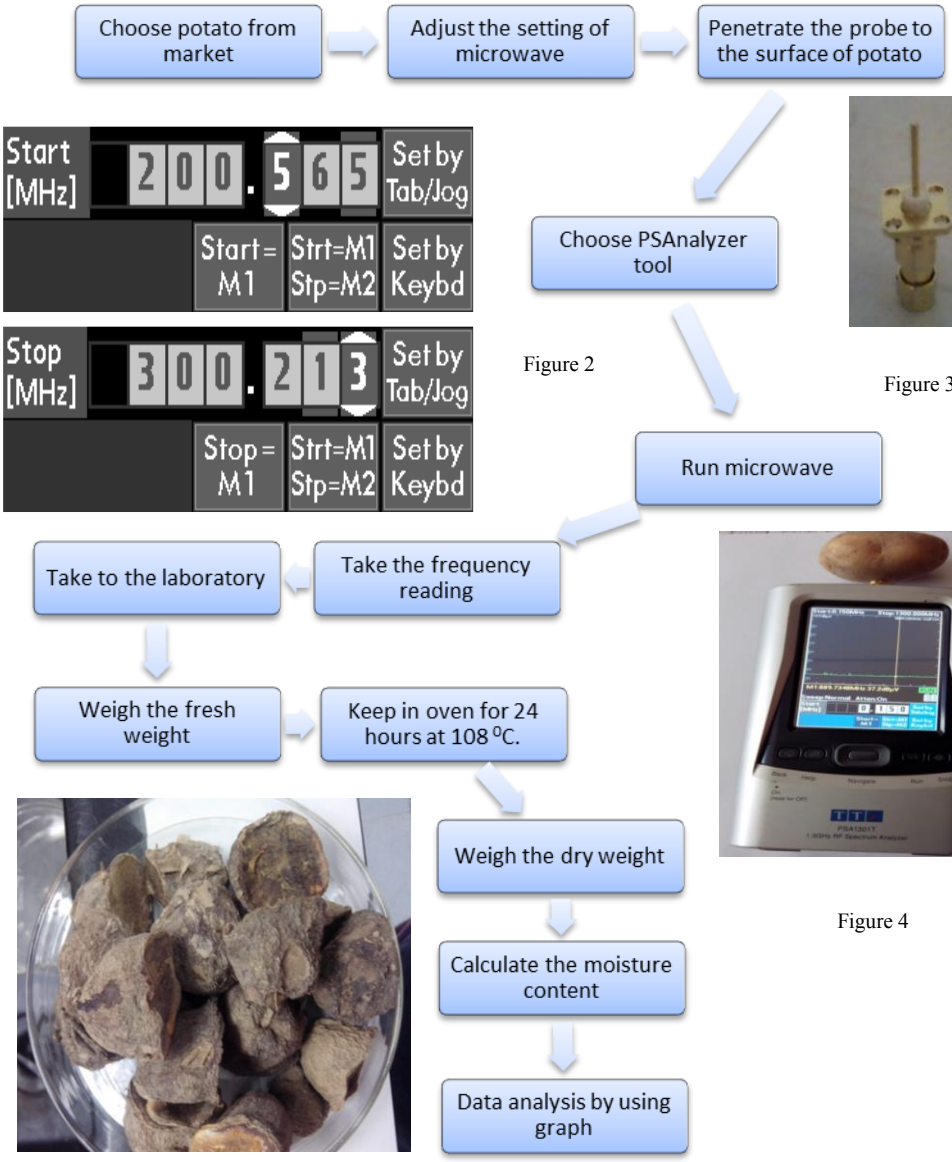


Figure 2



Figure 3



Figure 4



Figure 5

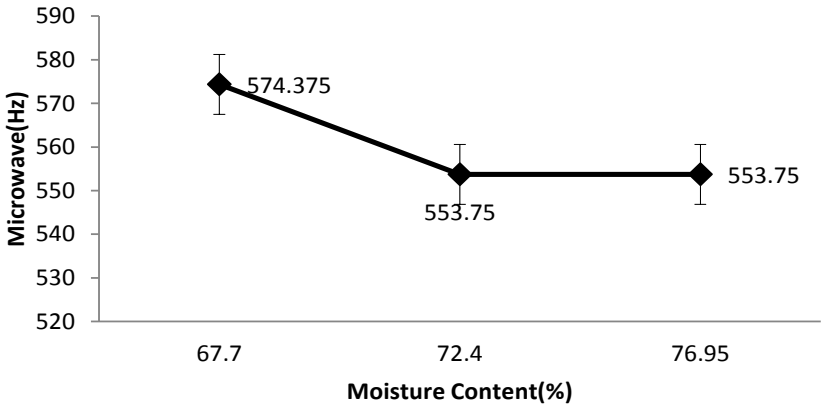


Figure 9: Graph of microwave against MC for first trial

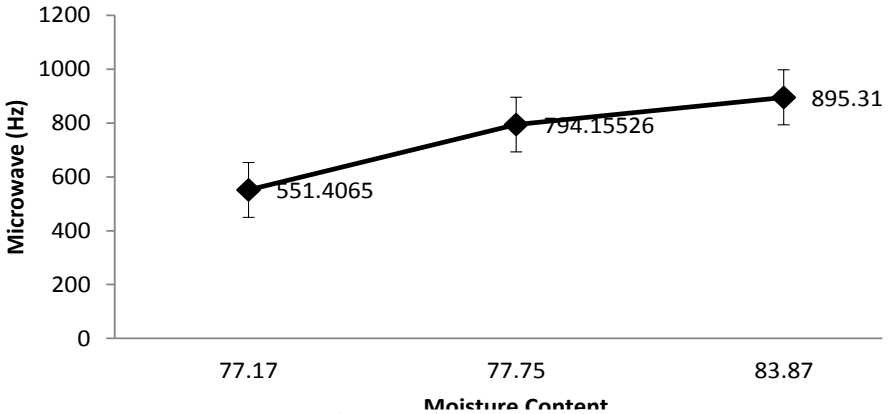


Figure 10: Graph of microwave against MC for second trial

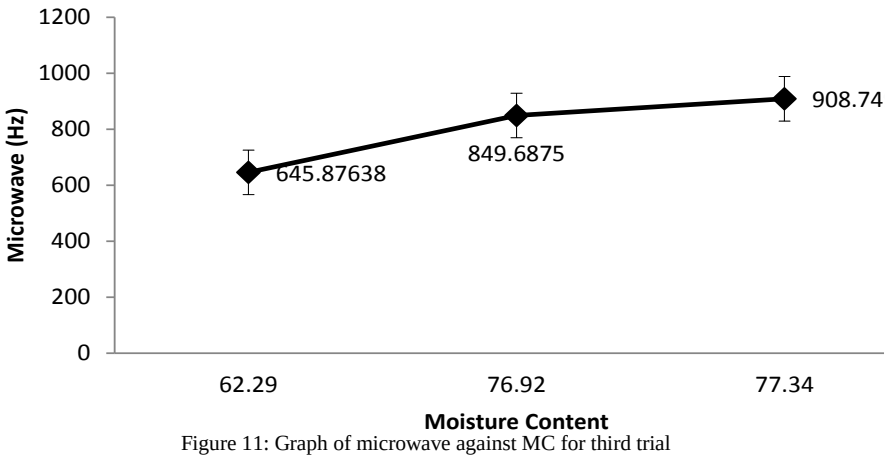


Figure 11: Graph of microwave against MC for third trial