Use of Sound Waves in Increasing Shelf Life of Banana

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Abstract - Banana is one of the most widely produced and consumed fruits in the world, but their short ripening period is a major disadvantage. Many chemical and physical method are currently being used to delay ripening of bananas, which are hazardous and expensive. Sound wave treatment has applied successfully to various commodities to control their ripening. The present study analyzed the effectiveness of using soundwave treatment for controlling ripening of Kolikuttu banana. The treatment was applied for same aged bananas in their mature green stage inside a soundproof box with three sound waves frequencies (600Hz, 1000Hz, 1500Hz) for continuous 06 hours. As the control, a sample without soundwave treatment was analysed. After the sound wave treatment ripening levels were measured using banana ripening chart, starch breakdown patterns, pulp to peel ratio, titratable acidity, pH value and total soluble solids on 1st, 3rd, 5th, 7th and 9th day and the results were statistically analyzed. Controlled banana sample reached their fully ripened level by 5 days while 600 Hz sample took 11 days and 1000 Hz and 1500 Hz samples took 13 days. According to the results there was a significant effect from sound wave treatment for the ripening of bananas (ANOVA, P = 0.000). When conferring the time series analysis of tested parameters, the1000 Hz treated banana samples showed the best increase in shelf life. Therefore, this frequency can be used to develop ecofriendly, cost-effective sound wave treated system to delay ripening of banana and reduce post-harvest loss.

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Keywords: Banana, Ripening, Post-harvest loss, Sound waves

I. INTRODUCTION

Banana is one of the most widely produced and consumed fruits in the world. Normally, bananas are harvested when they are young and consumed when they have fully ripened. An immature banana usually takes three to four days to ripen [1]. When compared to other fruits, the main disadvantage of bananas is their fast ripening due to ethylene. Ethylene is a colourless gaseous plant hormone that regulates a variety of processes [2]. To minimize the post-harvest loss of bananas, their ripening period has to be extended. Researchers have tried a variety of scientific approaches to delay the ripening of bananas such as use of salicylic acid [1], use of 1-MCP microbubbles [3] and use of light triggered release of nitric oxide [3]. However, these methods could be hazardous, expensive and not environmentally friendly. The utilization of sound waves as a factor in ripening delay is a revolutionary concept that has been used previously for vegetables such as tomatoes [4]. Using sound waves to delay the banana ripening has advantages as this is an environmentally friendly method. Also, this is a better way of avoiding hazardous chemicals and other agents. Further sound stimulation may improve disease resistance while reducing the need for chemical fertilizers and biocides [2].

The present study analysed the use of sound waves in extending shelf life of Kolikuttu bananas {Musa spp. (Kollikuttu)} considering its wide usage around the country.

II. MATERIALS AND METHODS

A. Collection of bananas

Kolikuttu variety of banana fruits were purchased from a cultivation land in Badulla through a local buyer. All the bananas were of the same bunch, and were free of any chemical agents.

B. Preparation of soundproof box

First, two different sized wooden boxes {(Large-25*25*25 inches) (Small-20*20*20 inches)} were prepared. Then, sound insulation foam was glued to each side of the large wooden box and a small box was placed inside the large box. Six speakers were placed on each side of small box to distribute the sound waves.

C. Programming the frequency generating software

Software was coded by python programming language using sound devices, NumPy and math libraries. The software resulted two dialog boxes which was inserted with the required frequency for specific time.

D. Treatment of banana with sound waves

Bananas were treated with sound waves of 600 Hz, 1000 Hz and 1500 Hz respectively for continuous six (6) hours inside the sound proof box. Sixteen banana fingers were treated with one soundwave treatment and three replicates were carried out for each frequency. As the control the same amount of banana fingers were kept in the same environment without soundwave treatment. Finally, the bananas were stored under room temperature for further monitoring.

E. Experiments to detect the ripening level

Both sound-treated and controlled banana samples were analyzed using several tests to detect their ripened level on 1st, 3rd, 5th, 7th and 9th day after the sound wave treatment. As the tests, detection of the ripening level using banana ripening chart, study of the starch breakdown patterns, analysis of pulp to peel ratio, and measurement of titratable acidity, pH value and total soluble solids were carried out.

F. Data analysis

The experiment was carried out in a Completely Randomized Design (CRD) with three replicates. The data were subjected to analysis of variance (ANOVA)using the Minitab 19 statistical software. The results showing significant differences were then subjected to mean separation using Tukey Pairwise Comparison Test.

III. Results and Discussion

A. Results according to banana ripening chart

Controlled banana sample reached their fully ripened level (according to the chart) by 5 days while 600 Hz sample took 11 days and 1000 Hz and 1500 Hz samples took 13 days. These findings conclude that, not all the sound wave frequencies but some frequency ranges may delay the ripening of banana (Fig. 1).

B. Results from laboratory experiments

According to the results there is a significant difference among sound wave treated samples and controlled samples in Pulp to peel ratio, Titratable acidity, pH value and Total soluble solids (ANOVA, P= 0.000).

Furthermore, Tukey pairwise comparison was used to group the information at 95% confidence. The results also revealed that there is a significant difference between controlled and treated samples proving that sound wave treatment has affected the ripening of the banana.

Time series analysis was performed for variations in pulp to peel ratio, titratable acidity, pH value and total soluble solids with time. From these, Pulp to peel ratio, pH value and Total soluble solid values had increased with time showing a similar pattern. On the other hand, titratable acidity values had decreased with time. The results revealed that controlled banana samples always showed fast ripening compared to the sound treated samples. A study done for tomatoes to increase shelf life using sound waves, revealed that the expression level of several ethylene biosynthetic and ripening-regulated genes was affected by sound wave treatment [4]. The same mechanism must be the reason for delaying of the ripening of the banana when they were treated with sound wave frequencies.

Further time series analysis revealed that 1000 Hz was the best frequency, which increased the shelf life of banana. Consequently, this frequency can be used to develop ecofriendly, cost-effective sound wave treated system to delay ripening of banana and reduce post-harvest loss.

Fig. 1 ripening of banana Day 05. a) 1000 Hz treated sample b) control sample.

IV. Conclusion

The utilization of sound waves as a method of delaying banana ripening is a revolutionary concept. Our results revealed that sound wave treatment on bananas can be used in increasing the shelf life of banana. From the frequencies studied, 1000 Hz frequency gave the best result in delaying the ripening of banana. This ecofriendly, cost effective and healthy method can be further developed to reduce post-harvest loss in banana industry. This study paved the way for additional research on the effects of sound waves on plant responses. The results of this study suggest that acoustic biology can be useful in agriculture and may aid in improving product quality and decreasing losses. This study also offers the first proof that sound treatment can increase the shelf life of banana fruit. Future research must include more in-depth analysis because this field is still in its infancy.

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