Towards Sustainable Postharvest Management: Extending Shelf Life of Banana (*Musa Acuminata × Balbisiana*) with Potassium Permanganate and Salicylic Acid

Roldan T. Quitos[1,2], John Vincent A. Nate[1,2], Jyme Jethro G. Natividad[1], Novalyn G. Delos Santos[1] and Luzviminda S. Quitos[3]

[1]Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija

[2]Crops and Resources Research and Development Center, Central Luzon State University, Science City of Muñoz, Nueva Ecija

[3]Department of Environmental Science, College of Science, Central Luzon State University, Science City of Muñoz, Nueva Ecija

DOI: https://doi.org/10.51244/IJRSI.2024.11110027

Received: 08 October 2024; Accepted: 12 October 2024; Published: 03 December 2024

ABSTRACT

This study explores the effects of postharvest treatments on the quality and sensory acceptability of banana (*Musa acuminata × balbisiana*) fruits. The bananas were treated with salicylic acid (SA), potassium permanganate ($KMnO_4$), and a combination of both $KMnO_4$ and SA to delay ripening and extend shelf life. The objective was to assess the impact of these treatments on various sensory attributes, including color, aroma, sweetness, firmness, and aftertaste. Sensory evaluation revealed that the control (untreated) and SA-treated bananas received significantly higher ratings for color, aroma, sweetness, and firmness compared to the $KMnO_4$ and $KMnO_4$+SA treatments. Specifically, the control and SA treatments were favored for their color, with moderate to high liking for sweetness and firmness. The aroma of the control was significantly more favorable than that of the $KMnO_4$ and $KMnO_4$+SA treatments, which had a lower sensory score for aroma. Potassium permanganate treatments, while effective in slowing ripening, were less liked for sweetness, firmness, and aftertaste. The aftertaste was particularly less favorable in the $KMnO_4$ and $KMnO_4$+SA groups compared to the control. These results suggest that salicylic acid provides a better balance of sensory attributes compared to potassium permanganate in extending the shelf life of bananas. This study offers valuable insights into the potential use of these treatments in the postharvest handling of bananas to improve their shelf life and consumer acceptability. The findings contribute to the growing body of research focused on sustainable agricultural practices and the use of natural plant growth regulators in fruit preservation.

Keywords: Postharvest Treatments, Banana Ripening, Sensory Evaluation, Potassium Permanganate, Salicylic Acid

INTRODUCTION

Bananas, belonging to the genus *Musa* and the family Musaceae, are among the most significant fruit crops worldwide. Exclusively grown in tropical regions, they are recognized for their year-round availability, distinctive flavor, and rich nutritional profile, including potassium, fiber, and vitamins B6 and C. The Saba variety, in particular, is one of the most harvested in the Philippines and plays an important role in the local agricultural economy. Bananas undergo a climacteric ripening process that significantly impacts their taste, texture, and nutritional properties. As bananas ripen, the breakdown of starches into simple sugars occurs, increasing sweetness and reducing bitterness and acidity, which makes the fruit more appealing to consumers (Moirangthem et al., 2018).

However, the rapid ripening of bananas, especially varieties like Saba, poses a challenge for producers and consumers alike. This accelerated ripening leads to overripening, mechanical damage, and postharvest losses, significantly affecting the fruit's quality and market value. Farmers and traders struggle to manage the fruit's short shelf life, as bananas need to reach the market within a few days after harvesting. While various methods to delay ripening exist, many of them involve costly and hazardous chemicals, making them impractical for small-scale farmers. Potassium permanganate ($KMnO_4$) and salicylic acid (SA), however, are cost-effective, readily available alternatives known for their ability to delay the ripening process in other fruits (Oshiro et al., 2013). This study seeks to explore the potential of these compounds in extending the shelf life of bananas, specifically the Saba variety, through their effects on ripening and fruit quality.

This research focused on evaluating the physical and chemical properties of bananas treated with $KMnO_4$ and SA, as well as their shelf life and sensory characteristics, including taste and appearance. The findings of this study could offer valuable insights into more sustainable and economically viable postharvest management practices. By reducing ripening speed and preventing overripening, these treatments have the potential to minimize losses, enhance fruit quality, and improve marketability, benefiting both producers and consumers. This study may also serve as a basis for further research into postharvest management techniques for other fast-ripening fruits, contributing to broader agricultural sustainability efforts.

METHODOLOGY

Materials

The materials used in this study were commercially available and easily accessible. These included bananas (Saba variety), potassium permanganate, salicylic acid, fruit crates, used paper, paper strips, water sprayer, measuring tape, thermometer, Atago Refractometer, and Biobased Colorimeter. The Atago Refractometer, manufactured by ATAGO Co., Ltd., is a precision instrument commonly used in food, beverage, and chemical industries to measure the refractive index of liquids and solids, with models like the ATAGO PAL-1 offering portability and accuracy for assessing concentrations such as sugar or alcohol levels. In contrast, the Biobased Colorimeter, used to measure the color of bio-based materials like biodegradable plastics or organic products, helps ensure consistency and quality control. Both devices are essential for industries that require precise measurements, with the refractometer focusing on concentration levels and the colorimeter ensuring uniform color quality in bio-based products.

Experimental Design

The experiment followed a Complete Randomized Design (CRD) with four treatments, each replicated three times. The treatments were as follows:

- Treatment 1: Salicylic Acid Solution
- Treatment 2: Salicylic Acid Solution + $KMnO_4$ Strips
- Treatment 3: $KMnO_4$ Strips
- Control: No treatment

For the preparation of the treatments, 10 grams of potassium permanganate was dissolved in 1000 mL of water, and paper strips were soaked in the solution. Similarly, 128 grams of salicylic acid was dissolved in 1000 mL of water. The treated bananas were placed in fruit crates and stored under normal conditions until ripened. In the study of Srivastava & Dwivedi (2000), the rate of respiration was found to increase with ripening exhibiting a peak on day 4 (climacteric peak) for Salicylic acid that was served as basis for this experiment design. This is also the same with the study of Gutierrez-Aguirre et. al. (2023) highlighting potassium permanganate was efficient in reducing the metabolism of fresh bananas stored at 23°C preserving the titratable acidity and color and having a low weight loss rate and low total soluble solids for 19 days.

Thus, this study explored the efficacy of these chemicals including its combination for Philippine’s banana.

Data Gathered

1. Physiological Loss in Weight (%)

The bananas were weighed on a digital balance at the start and when they were fully ripened. The weight loss was calculated using the formula:

$$\mathrm{WL}\ (\%) = \frac{\mathrm{WI}-\mathrm{WF}}{\mathrm{WI}} \times 100$$

where WI is the initial weight and WF is the final weight of the fruit. This was based on the established Moisture Loss Equation.

2. Fruit Decay (%)

The number of rotten banana fingers was counted at regular intervals, and the decay percentage was calculated using the formula:

$$\mathrm{FD}\ (\%) = \frac{\text{Number of Rotten Fingers}}{\text{Total Number of Fingers}} \times 100$$

3. Total Soluble Solids (TSS)

TSS was determined using an Atago refractometer on the first and final days of storage.

4. Temperature and Humidity Check

Temperature and humidity levels were monitored throughout the experiment, from the start of the storage period until the bananas reached full ripeness.

4. Color Observation and Monitoring The color of the bananas was measured using the CIELAB color scale.

$$\Delta E = \sqrt{(L^* - L_o^*)^2 + (a^* - a_o^*)^2 + (b^* - b_o^*)^2}$$

Lo*, ao*, and bo* were measured using a biobase colorimeter before the storage process of the banana and L*, a*, and b* were measured after the banana reached full ripeness.

5. Shelf Life

Shelf life was determined by the number of days from treatment application until the bananas fully ripened. The normal ripening period for bananas is five days in the Philippine market setting considering its farm-to-market delivery duration and its marketable characteristics; any extension of this period due to the treatments was noted.

6. Sensory Evaluation

Sensory evaluation was conducted with 50 randomly selected participants from Central Luzon State University. Eligibility criteria included regular consumption of bananas, no specific dislike or allergies to bananas, and willingness to participate. Sensory attributes such as taste, texture, and overall acceptability were assessed using a hedonic scale.

The demographic table provides an overview of the 50 participants who took part in the sensory evaluation study at Central Luzon State University. All participants were undergraduate Food Technology students from CLSU, between the ages of 18 and 24. Participants were randomly selected from this specific group to maintain relevance to the study's focus on food assessment. Both genders were represented, ensuring a balanced demographic profile.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XI November 2024

The students were compensated with a total of PhP 4,500 for participating in the sensory evaluation. This compensation covered the entire testing period and served as an incentive to ensure engagement and participation in assessing sensory attributes such as taste, texture, and overall acceptability.

7. Statistical Analysis

Data were analyzed using one-way analysis of variance (ANOVA) with IBM SPSS Statistics® 26. Significant differences between treatments were determined using the Tukey HSD post hoc test at a 5% significance level.

RESULTS AND DISCUSSION

Storage Conditions

Small-scale traders typically store bananas, particularly the "Saba" cultivar (*Musa acuminata balbisiana*), in fruit crates for market transport. Bananas are known to ripen fully in 2 to 5 days at room temperature (Revell, 2023). In this study, the ripening process was replicated to match the handling methods of market traders. Approximately 220 banana fingers were observed under experimental conditions designed to delay ripening, using potassium permanganate ($KMnO_4$) and salicylic acid (SA). Physical and chemical properties, including sensory attributes (color, aroma, aftertaste, sweetness, and firmness), were monitored throughout the ripening process.

Temperature and Relative Humidity

Temperature and relative humidity were monitored over a seven-day period using a thermohygrometer. As shown in Figure 1, the relative humidity fluctuated between 62% and 77%, while the temperature ranged from 24.4°C to 28°C. These environmental factors are crucial in the ripening process of bananas, where higher temperatures and humidity accelerate the production of ethylene, a key hormone in fruit ripening (Ahmad et al., 2018; Supannaklang & Shiesh, 2018).

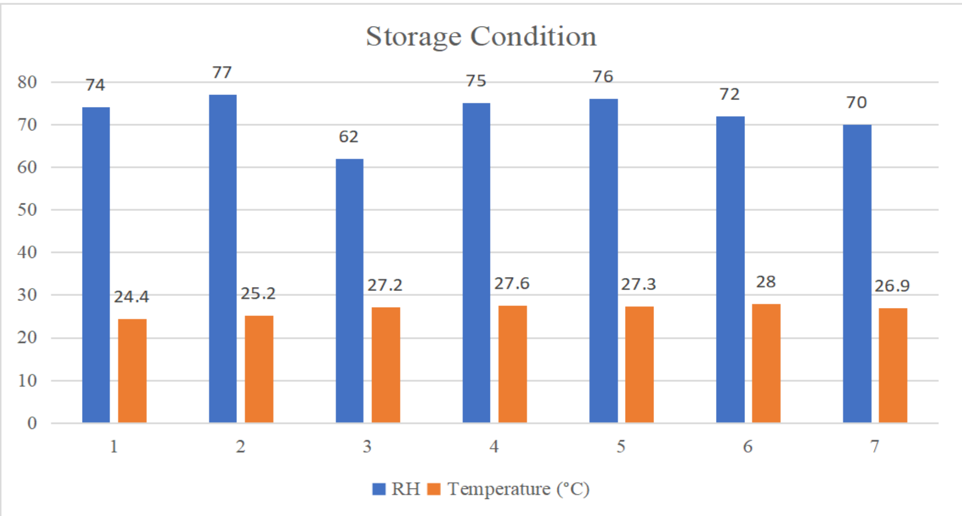

Figure 1. Storage Condition

Physiological Loss in Weight (PLW)

Physiological weight loss was recorded by measuring the initial and final weight after ripening as shown on Table 1. The PLW ranged from 1.25% to 3.17%, with the highest loss in the $KMnO_4$-treated bananas and the lowest in the salicylic acid (SA)-treated bananas. One-way analysis of variance (ANOVA) showed no significant difference between treatments (p = 0.782), indicating that the treatments did not significantly affect weight loss during ripening. Transpiration and respiration are typically responsible for weight loss in fresh fruits (Abiso et al., 2018). The Table 1 also emphasized that the control is relatively lower the pure salicylic acid

Table 1. Physiological Loss in Weight

Treatments	Physiological loss in Weight (%)	Sig
Control	1.91	*p=0.782*
Salicylic Acid	1.59	
Salicylic Acid & $KMnO_4$	1.98	
$KMnO_4$	2.07	

Decay Percentage

Decay percentage was determined by counting spoiled banana fingers across treatments. Results showed no significant differences (p = 0.441). Most treatments exhibited 0% decay, except for the second replication of the salicylic acid + $KMnO_4$ (BSAP) treatment, which showed 5.56% decay. This suggests that while the treatments slowed ripening, they did not significantly affect fruit decay, likely due to ethylene production, which accelerates both ripening and decay (Godana & Alemnew, 2018).

Total Soluble Solids (TSS)

The total soluble solids (TSS) were measured using an Atago refractometer, and one-way ANOVA revealed highly significant differences (p = 0.001) as shown in Table 2. The highest TSS was observed in the SA-treated bananas (18°Brix), while the lowest was in the $KMnO_4$-treated bananas (14.4°Brix), indicating a difference in the ripening dynamics caused by the treatments.

Table 2. Total Soluble Solids.

Treatments	TSS		Sig
	Initial	Final	
Control	2.93	15.90	*p=0.782*
Salicylic Acid	2.67	18.00	
Salicylic Acid & $KMnO_4$	3.00	16.86	
$KMnO_4$	2.73	14.60	

Color Values

The color properties of bananas were evaluated after seven days, with the control bananas ripening within five days as shown in Table 3. The CIELAB color values (L*, a*, b*, chroma c*, and hue angle h°) were measured to assess ripening, with higher chlorophyll content resulting in lower color scores.

Table 3. Color Values (CIELAB Lab, chroma c, and hue angle h°)

	L*	a*	b*	c*	h°	ΔE
Control (unripe)	46.38	-13.59	22.25	27.08	124.41	**27.88**
Control (ripe)	66.11	1.22	35.49	35.53	88.05	
Salicylic Acid (unripe)	49.21	-13.31	22.43	26.09	120.74	**26.20**
Salicylic Acid (ripe)	67.80	0.93	34.18	34.23	88.46	
Salicylic Acid & $KMnO_4$ (unripe)	48.01	-13.33	24.83	28.21	118.30	**26.24**
Salicylic Acid & $KMnO_4$ (ripe)	66.74	0.98	36.37	36.38	88.44	
$KMnO_4$ (unripe)	48.9	-13.19	23.96	27.35	118.73	**27.40**
$KMnO_4$ (ripe)	66.43	1.39	39.15	39.17	87.95	

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XI November 2024

Bananas treated with SA and $KMnO_4$ exhibited delayed ripening, as reflected in their lower color values compared to the control. These values correlate with the visual assessment of ripeness, supporting the delayed ripening observed.

Monitoring the Number of Days

At room temperature, properly stored bananas typically reach full ripeness in 2 to 5 days (Revell, 2023). As shown in Figure 2, $KMnO_4$-treated bananas took 7 days to ripen fully, while SA-treated bananas ripened in 6 days. The control bananas ripened in 5 days. This indicates that potassium permanganate delayed the ripening process by at least two days compared to the control.

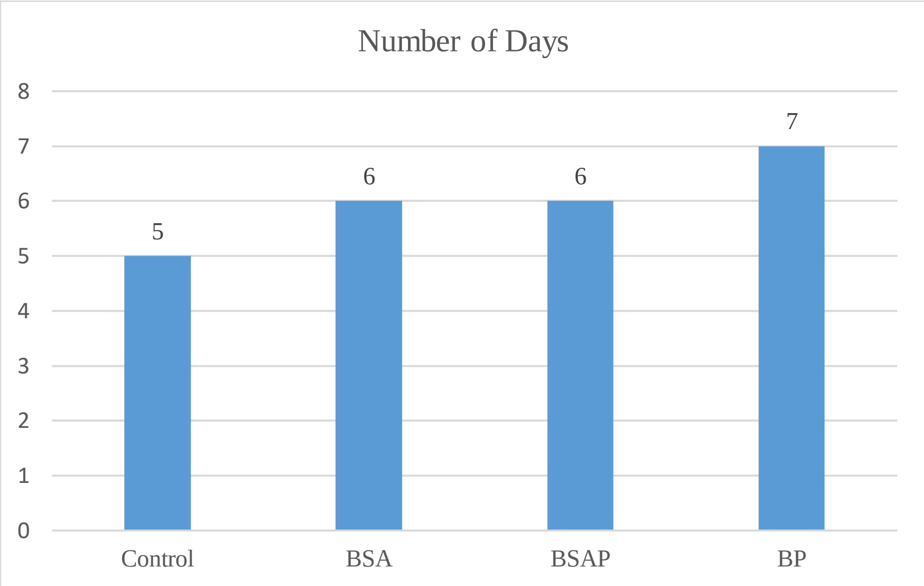

Figure 2. Monitoring the Number of Days after the treatment applications

Sensory Evaluation

The Control bananas received the highest overall acceptability (7.9), indicating a preference for untreated bananas with ideal sensory qualities such as aroma, sweetness, and texture, aligning with findings from previous studies on ripening behavior (Ahmad et al., 2018). Salicylic acid (7.5) showed slightly lower acceptability, while the combination of salicylic acid and potassium permanganate (6.9) and potassium permanganate alone (6.8) received even lower scores, possibly due to altered texture or flavor. The statistically significant difference ($p < 0.000008$) between the control and the treatments suggests that while chemical treatments can delay ripening, they may impact sensory preferences negatively, aligning with earlier research on consumer preference for naturally ripened bananas (Kritsada Supannaklang & Ching-Chang Shiesh, 2018).

Table 4. Overall acceptability^{+} score of bananas (n = 50)

Code (Sample Identity)	Mean* Overall Acceptability	SD	Sig
Control	7.9^a	0.7	p = <0.000008
Salicylic Acid	7.5^a	1.2	
Salicylic Acid & $KMnO_4$	6.9^b	1.2	
$KMnO_4$	6.8^b	1.6	

*Means with same letter superscript within the same column are not significantly different at 5% level +Based on a 9-point hedonic scale with 100 respondents where 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = extremely like

The hedonic scale was used in this study and defined the results of a sensory evaluation using a 9-point hedonic scale with 50 participants. It mentions that means with the same letter superscript in the same column

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XI November 2024

are not significantly different at the 5% level, meaning no statistically important difference between those values. The scale ranges from 1 (extreme dislike) to 9 (extreme like), with intermediate values representing varying levels of like or dislike. The analysis ensures that differences in ratings are meaningful and not just due to chance.

The table 4 and 5 shows the sensory evaluation as overall capacity of the banana samples revealed that the Control and Salicylic Acid treatments received significantly higher ratings for color, as compared to Salicylic Acid & $KMnO_4$ and Potassium Permanganate treatments. Both Control and Salicylic Acid treatments were moderately liked, while Salicylic Acid & $KMnO_4$ and Potassium Permanganate treatments were rated lower in terms of color preference. When it comes to aroma, the Control was the most favored, significantly outshining Salicylic Acid & $KMnO_4$ and Potassium Permanganate treatments. Salicylic Acid treatment, however, showed comparable results to all treatments. For sweetness, the Control and Salicylic Acid treated samples were perceived as "liked very much" and had significantly higher scores than Salicylic Acid & $KMnO_4$ and Potassium Permanganate treatments, which were only moderately liked. In terms of firmness, the Control and Salicylic Acid treated bananas were favored, slightly edging out the other treatments. The Potassium Permanganate treated banana was the least liked for firmness, while the Salicylic Acid & $KMnO_4$ and Potassium Permanganate treated banana had the lowest mean score for this attribute. Finally, aftertaste ratings were highest for the Control, which was considered "liked moderately," while Potassium Permanganate had the lowest scores for aftertaste. Salicylic Acid and Salicylic Acid & $KMnO_4$ treated banana's aftertastes were similar to Potassium Permanganate treated bananas but not as favored.

Table 5. Sensory Evaluation of Banana Samples Treated with Salicylic Acid, Potassium Permanganate, and Their Combination for 50 participants.

Treatments	**Attribute: Color**
Control	Most favored (moderately liked)
Salicylic Acid	Most favored (moderately liked)
Salicylic acid and potassium permanganate	Lower preference
Potassium permanganate	Lower preference
	Attribute: Aroma
Control	Highest preference (significantly higher)
Salicylic Acid	Highest preference (significantly higher)
Salicylic acid and potassium permanganate	Lower preference
Potassium permanganate	Lower preference
	Attribute: Sweetness
Control	Liked very much (significantly higher)
Salicylic Acid	Liked very much (significantly higher)
Salicylic acid and potassium permanganate	Moderately liked
Potassium permanganate	Moderately liked
	Attribute: Firmness
Control	Most favored
Salicylic Acid	Most favored
Salicylic acid and potassium permanganate	Least favored
Potassium permanganate	Least favored
	Attribute: Aftertaste
Control	Liked moderately (highest)
Salicylic Acid	Liked moderately (highest)
Salicylic acid and potassium permanganate	Similar to potassium Permanganate treated banana but less favored
Potassium permanganate	Least favored

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue XI November 2024

CONCLUSION

This study examined the effectiveness of Salicylic Acid and Potassium Permanganate in delaying the ripening process of bananas, particularly focusing on sensory qualities such as color, aroma, sweetness, firmness, and aftertaste. The results indicate that both treatments were successful in slowing down ripening, with Salicylic Acid and Potassium Permanganate significantly delaying ripening compared to the control. Sensory evaluations showed that the control treatment (ripened naturally) had the highest overall acceptability, with respondents rating it most favorably in terms of aroma, sweetness, and firmness. Among the treatments, Salicylic Acid performed well in terms of color, aroma, and sweetness, with ratings comparable to the control, while Potassium Permanganate was less favored, particularly in firmness and aftertaste. These findings suggest that Salicylic Acid holds potential for extending shelf life and maintaining desirable sensory attributes of bananas during storage. However, while both treatments showed promise in delaying ripening, Potassium Permanganate's effect on firmness and aftertaste calls for further research to optimize its use. These results contribute to postharvest management strategies aimed at improving the shelf life and marketability of bananas, which is crucial for small-scale traders and consumers alike.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed for the postharvest management of bananas:

1. Salicylic Acid as a Preferred Treatment
2. Further Optimization of Potassium Permanganate
3. Combination Treatments
4. Sensory Evaluation as a Key Indicator
5. Implementation in Small-Scale Trade

REFERENCES

1. Agron, A. (2017). Potassium permanganate effects on the quality and postharvest conservation of sapodilla (Manilkara zapota (L.) P.Royen) fruits under modified atmosphere. Retrieved from http://www.scielo.org.co/pdf/acag//0120-2812-acag-66-03-00331.pdf
2. Al-Dairi, M., Pathare, P. B., & Al-Yahyai, R. (2021). Effect of postharvest transport and storage on color and firmness quality of tomato. Horticulturae, 7(7), 163. https://doi.org/10.3390/horticulturae7070163
3. Barua, S., et al. (2015). Delay in fruit ripening: A promising approach for reduction of spoilage and use of hazardous chemicals in Bangladesh. Retrieved from https://www.researchgate.net/ publication/ 275212599 Delay in fruit ripening a promising approach for reduction of spoilage and use of hazardous chemicals in Bangladesh
4. Correa, S.F., et al. (2005). Effect of the potassium permanganate during papaya fruit ripening: Ethylene production. Retrieved from https://ui.adsabs.harvard.edu/abs/2005JPhy4.125..869C/abstract
5. De Souza Freitas, W.E., et al. (2017). Potassium permanganate effects on the quality and postharvest conservation of sapodilla (Manilkara zapota (L.) P. Royen) fruits under modified atmosphere. Retrieved from http://www.scielo.org.co/pdf/acag/v66n3/0120-2812-acag-66-0300331.pdf
6. Gutierrez-Aguirre B.K., Llave-Davila R.E., Olivera-Montenegro L.A., Herrera-Nuñez E., Marzano-Barreda L.A.
7. Effect of Potassium Permanganate as an Ethylene Scavenger and Physicochemical Characterization during the Shelf Life of Fresh Banana (Musa paradisiaca). Int J Food Sci. 2023 Aug 22; 2023:4650023. doi: 10.1155/2023/4650023
8. Helgi Analytics. (2019). Banana Consumption Per Capita in Philippines. Retrieved from https://www.helgilibrary.com/indicators/banana-consumptionper-capita/philippines/
9. Kocher, C. (2020). What does a stage % banana mean? Medium. Retrieved from https://medium.com/swlh/what-does-a-stage-5-banana-mean45ae20679fc1

10. Koshita, Y. (2014). Effect of temperature on fruit color development. In Springer eBooks (pp. 47–58). https://doi.org/10.1007/978-4-431-55251-2_4
11. Larotondo, F.D., et al. (2008). Study of banana (Musa aaa Cavendish cv Nanica) trigger ripening for small scale process. Retrieved from https://www.scielo.br/j/babt/a/ 5tXHXQCNxq QSwV9X 7RmR4jm/?format=pdf&lang=en
12. Liu, M., Pirrello, J., Chervin, C., Roustan, J., & Bouzayen, M. (2015). Ethylene control of fruit ripening: Revisiting the complex network of transcriptional regulation. Plant Physiology, pp.01361.2015. https://doi.org/10.1104/pp.15.01361
13. Moirangthem, K., & Tucker, G. (2018). How do fruits ripen? Frontiers for Young Minds. Retrieved from https://kids.frontiersin.org/articles/10.3389/frym.2018.00016
14. National Geographic. (2017). The surprising science behind the world's most popular fruit. Retrieved from https://www.nationalgeographic.com/environment/article/food-journeysgraphic
15. Philippine Farmers. (2020). 12 varieties of banana. Retrieved from https://www.facebook.com/philippinefarmers/photos/a.101527896752767
16. Silva, D. F. P., et al. (2009). Potassium permanganate effects in postharvest conservation of the papaya cultivar Sunrise Golden. Retrieved from https://www.scielo.br/j/pab/a/ BK73jBgjW6BtzbZ6SryghKL/ ?lang=en&format=pdf
17. Srivastava M.K. and Dwivedi U.K. (2000). Delayed ripening of banana fruit by salicylic acid. Plant Science Volume 158, Issues 1–2, 8 September 2000, Pages 87-96. https://doi.org/10.1016/S0168-9452 (00)00304-6.
18. Sujayasree, O. J., et al. (2017). Potassium permanganate ($KMnO_4$) as an effective antiethylene agent to delay fruit ripening: Recent advances. Retrieved from http://www.aelsindia.com/rjcesapril2017/11.pdf
19. Telesco, P. (2019). How long does it take for a banana to ripen? SFGate. Retrieved from https://homeguides.sfgate.com/long-banana-ripen-83137.html
20. The Editors of Encyclopedia Britannica. (2020). Banana. Retrieved from https://www.britannica.com/plant/banana-plant
21. Travel Online. (n.d.). Philippines weather & climate. Retrieved from https://www.travelonline.com/philippines/weather.html
22. Vendrell, M. (1969). Acceleration and delay ripening in banana fruit tissue by gibberellic acid. Retrieved from https://www.publish.csiro.au/bi/pdf/BI9700554
23. Villazon, L. (n.d.). Why do banana skins get thinner as the fruit ripens? Science Focus. Retrieved from https://www.sciencefocus.com/nature/why-do-banana-skins-get-thinner-as-the-fruit-ripens/