BIOEDUPAT:
Pattimura Journal of Biology and Learning
https://ojs3.unpatti.ac.id/index.php/bioedupat
e-ISSN 2775-4472

Research Article

Effect of calcium carbide on the rate of ripening of Ambon Bananas (*Musa paradisiaca Var. Sapientum* (L). Kunt)

Jeyssen Lincon Loupatty[1], Gloria Eka Sari Tuhumena[2], Gysella Velove Limba[3], Ayu Wariunsore[4], Zipora V Noya Van Delzen[5], Juen Carla Warella[6*], Gerce Anne Rumahlatu[7]

[1,2,3,4,5] Senior High School Laboratory of Universitas Pattimura, Jl. Ir. Putuhena, Ambon 97233, Indonesia
[6] Departement of Microbiology and Parasitology, Faculty of Medicine, Universitas Pattimura, Jl. Ir. Putuhena, Ambon 97233, Indonesia
** corresponding author: juen.warella@gmail.com*

Received: August 5, 2023 Revised: September 4, 2023 Accepted: October 6, 2023

ABSTRACT

Bananas are one of the most widely consumed sources of nutrients in Indonesia. Generally, bananas are consumed fresh and processed into various snacks. This leads to an increased demand for bananas in the market. However, the natural ripening process takes 7-8 days after harvest, which is a long time to meet consumer demand. One solution is to use calcium carbide to accelerate fruit ripening. The reason for using calcium carbide is that it is readily available and inexpensive, so banana producers use carbide as a fruit ripening agent. The objective of this study was to determine the effects of calcium carbide on fruit ripening of Ambon bananas. The method used was a laboratory experiment with a post-test-only control group design. There were three treatments with calcium carbide concentrations of 12%, 6%, and 3%, and positive control, namely rapining with rice. Data were analyzed descriptive qualitative by collecting, presenting, reducing, and conclusions. The process of fruit ripening can be observed using the variables of color, texture and aroma. The results obtained were differences in color, texture, and aroma at concentrations of 12%, 6%, and 3% based on the length of aging. Based on the color parameter, the concentration of 6% and 12% showed a blackish yellow/brown color, while the concentration of 3% was yellow with black spots. The texture parameters of the 6% and 12% concentrations had a very soft texture, while the 3% concentration had a smooth texture. The aroma parameters of the 12%, 6%, and 3% concentrations had a rancid aroma on day six, while days one, two, and three were fragrant. The conclusion is that using calcium carbide at different concentrations affects the rate of fruit ripening. The higher the concentration of calcium carbide used, the faster the respiration rate of the bananas, thus initiating the ripening process.

Keywords: Calcium carbide, bananas, organoleptic, fruit ripening

To cite this article:
Loupatty, J. L., Tuhumena, G. E. S., Limba, G. V., Wariunsore, A., Van Delzen, Z. V. N., Warella, J. C., & Rumahlatu, G. A. (2023). Effect of calcium carbide on the rate of ripening of Ambon Bananas (*Musa paradisiaca Var. Sapientum* (L). Kunt). *Bioedupat: Pattimura Journal of Biology and Learning*, Vol 3(2), 118-124. DOI: https://doi.org/10.30598/bioedupat.v3.i2.pp118-124

INTRODUCTION

Banana (*Musa paradisiaca*) is a tropical fruit distributed in tropical countries such as Latin America, Central Africa, Pacific Islands, Caribbean Islands, and Southeast Asia (Salas-Pascual and Cáceres-Lorenzo, 2022; Strobl and Mohan, 2020; Van Den Houwe et al., 2020). Indonesia ranks sixth among the world's largest banana producers, with an average production of 9.6 million tons or 5.67% of the world's total banana production in 2022 (Harto et al., 2019; Hastuti et al., 2019). Various banana species can be found on all islands of Indonesia, including Sumatra, Java, Kalimantan, Sulawesi, Bali, NTT, NTB, Maluku, and Papua. Banana species found in Indonesia include Ambon, Raja, Tongka Langit, Tanduk, Kepok, Cevendish, Susu, Mas and Barangan bananas (Hastuti et

al., 2019; Riandini et al., 2021; Saiya et al., 2020; Sulistyaningsih, 2016). Bananas are preferred by almost all people around the world because it has good taste, readily available, inexpensive, and have high nutritional value. (Harto et al., 2019). Bananas contain carbohydrates, protein, fat, vitamin C, fiber, and minerals (calcium, magnesium, iron, phosphorus, and potassium), which are useful for improving the digestive tract and as neurotransmitters in the smooth functioning of the brain (Hapsari and Lestari, 2016; Hasanah et al., 2017).

In general, Indonesians consume bananas in fresh form or directly eaten and processed into various snacks. This has resulted in higher consumer demand for bananas in the market (Markiah et al, 2020). Data from the Coordinating Ministry of Agriculture in 2022 shows that the average banana consumption in Indonesia is 24.71 grams/capita/day (Kemenko Perekonomian RI, 2022). However, this amount only reached 54.09% of the World Health Organization's (WHO) minimum nutritional requirement, so banana consumption still needs to be increased. One way to increase banana consumption is to make bananas available in large quantities on the market.This is certainly related to the post-harvest ripening process of bananas. Bananas are climacteric fruits with a high water content, which increases the respiration rate during the ripening process (Seyedabadi et al., 2019). However, the natural ripening process of bananas takes 5-8 days after harvesting, and depending on the type of banana, it can take a long time to meet the consumer demand (Akter et al., 2020; Kuang et al., 2021). One solution to accelerate fruit ripening is the use of calcium carbide.

Ripening is a method used to accelerate the ripening of fruit by storing it under certain conditions after harvesting (Brizzolara et al., 2020). The purpose of maceration is to accelerate the ripening process and homogenize the degree of maturity of the fruit (texture and color) (Firmansyah et al., 2022). The process of fruit ripening can be performed by storing in a closed container, wrapping in leaves, smoking, using ethylene gas, ethepon, or using carbides (calcium carbide) (Suryanti et al., 2017). Generally, banana producers use carbides to ripen the fruit. Carbide (calcium carbide) is a chemical compound with the chemical formula CaC_2, which reacts with water (H_2O) to produce ethylene gas (C_2H_2) and $Ca(OH)_2$, which accelerate the respiration process, resulting in fruit ripening (Oladipupo et al., 2022). Research by Firmansyah et al. (2022) on different doses of calcium carbide on plantain showed that the higher the concentration used, the faster the ripening time of the fruit and the nutritional content of plantain. The study (Wekti, 2018) on the use of calcium carbide on Ambon banana only measured the vitamin C content, while the study (Putri, 2023) used ethephon and methanol to measure the maturity of Ambon banana. However, using carbides with different concentrations on Ambon bananas has yet to be studied.

Based on this, the use of of calcium carbide can be used to meet consumer demand for bananas in the market. The purpose of this study was to determine the effect of using calcium carbide at concentrations of 12%, 6%, and 3% on the ripening rate of Ambon bananas based on the length of soaking with a positive control is soaking with rice.

METHODS

This research is a laboratory experiment using a post-test only control group design. This research was conducted at the Science Laboratory of Laboratory High School of Universitas Pattimura, which was held on September 15-22, 2022. Observations of changes in the ripening of Ambon bananas were made from day one to day six after harvest. The analysis was carried out descriptively and qualitatively by looking at the difference in concentration to the results of Ambon banana ripening based on the length of time used.

Materials and Tools

The materials used in this study were Ambon banana (*Musa Paradisiaca Var. Sapientum*) collected from Kairatu Village, West Seram, calcium carbide, rice, and distilled water. Samples were collected directly from the farm. The number of bananas taken was one bunch and in an old condition (harvest age 90-95 days). The physiological characteristics of harvested bananas are green fruit surfaces with a yellow or slightly yellow tinge.

Procedure

The Ripening process was carried out by making three concentrations of calcium carbide, namely the highest concentration of 12%, medium concentration of 6% and low concentration of 3%. Then, 15 g of calcium carbide was mixed with 100, 250, and 500 ml of distilled water. The Ambon bananas used were medium size with an average fruit length of 14-16 cm on the seventh or eighth comb, green fruit color with a yellow tinge. The banana was then wrapped in used paper until it was tightly closed, and sprayed with the prepared calcium carbide mixture until the entire surface of the paper was wet (Suryanti et al., 2017). The spraying was done once on the first day before curing with a spray bottle volume of 100ml. Bananas were stored on a cupboard and protected from sunlight for sixth days. The observation process was conducted from day one to day sixth (Arif and Balai, 2014). The same treatment was also applied to the positive control of bananas in rice. Each treatment was replicated in duplicate (Suryanti et al., 2017). The temperature used in this research process is room temperature, namely 28.

Observations were made from day one to day sixth to see changes in the parameters measured, including color, texture, and aroma.

On the sixth day, a descriptive organoleptic test was carried out with 40 panelists, consisting of X, XI, and XII-grade students of Laboratory High School of Universitas Pattimura. The parameter of each variable evaluated was aroma (fragrant, rancid, odorless, and other aromas) (Warella, 2023). Texture (hard, chewy, mushy) and color (yellow, brown, black). The organoleptic test was conducted by distributing questionnaires to the panelists to evaluate the cured bananas (Rachma et al., 2022). Each variable was expressed by an index to distinguish the changes that occurred. The banana color index is indicated by 1: full green; 2: green with some yellow; 3: green more than yellow; 4: comparable green and yellow; 5: yellow more than green; 6: full yellow; 7: yellow with some brown or black spots; 8: yellow with widespread black spots; 9: blackish/brownish yellow; 10: black. The banana texture index was indicated by 1: very hard, 2: hard, 3: slightly soft, 4: soft and 5: very soft. The banana aroma index is indicated by 1: fragrant, 2: rancid, 3: odorless, and 4: other aromas.

Analysis Data

Data analysis was performed descriptively and qualitatively using *Microsoft Excel 2019 software* and presented using graphs and tables.

RESULTS AND DISCUSSION

This study was conducted by comparing three concentrations of calcium carbide marinating based on the length of marinating and comparing it with rice marinating. Observations were made daily to determine the effect of using calcium carbide at three concentrations, and an organoleptic test was conducted on the sixth day.

Based on this research, the measured parameters differ based on the concentration used. Observation of the first day of color parameters at all concentrations is fully green, texture parameters at three concentrations are hard textured, and aroma parameters at three concentrations are fragrant. Day two observations of the color parameters of all concentrations were full green, hard textured at all concentrations, and fragrant at all concentrations. Day three observations of the color parameter of the 3% concentration showed the same green and yellow color, while the 6% and 12% concentrations showed a more dominant yellow color. The texture parameter showed that the 3% and 6% concentrations showed a hard texture, while the 12% concentration had a slightly soft texture. On the fourth day of observation, there was a color change that was more yellow than green at the 3% concentration and full yellow at the 6% and 12% concentrations. For the texture parameter, the 3% and 6% concentrations had a slightly soft texture, and the 12% concentration had a soft texture. The aroma produced by the 3% and 12% concentrations was fragrant, while the 6% concentration had a rancid aroma. On day five, all concentrations had a yellow color with a few brown or black spots and a soft texture at the 3% and 6% concentrations, while the 12% concentration had a very soft texture. The aroma produced by the 3% and 6% concentrations were rancid, whereas the 12% concentration had a fragrant aroma. On the sixth day, the color parameter showed a blackish-yellow/brownish color at concentrations of 6% and 12%, while the 3% concentration was yellow, with black spots becoming more widespread. The texture parameter of the 3% concentration was soft, and those of the 6% and 12% concentrations were very soft. The aroma parameters were rancid at all concentrations.

Based on these results, it can be seen that the higher the concentration, the higher the rate of fruit ripening on the sixth day, that is, at a concentration of 12%. This resulted in changes in the color, texture, and aroma of the Ambon banana. Table 1 shows the results of using calcium carbide at three concentrations.

The ripening process of the Ambon banana is shown in Figure 1. The ripening process took six days.

Table 1. The results of using calcium carbide at three concentration

Day	Calcium Carbide 3%			Calcium Carbide 6%			Calcium Carbide 12%			Rice		
	Color	Texture	Aroma	Color	Texture	Aroma	Color	Texture	Aroma	Color	Texture	Aroma
1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	2	1	1	2	1	1	2	1	2	2	1
3	4	2	1	5	2	1	5	3	1	3	2	1
4	5	3	1	6	3	2	6	4	1	4	3	2
5	7	4	2	7	4	2	7	5	1	7	4	2
6	8	4	2	9	5	2	9	5	2	9	5	2

The six-day ripening process of the Ambon bananas is shown in Figure 1. The six-day ripening process of Ambon bananas.

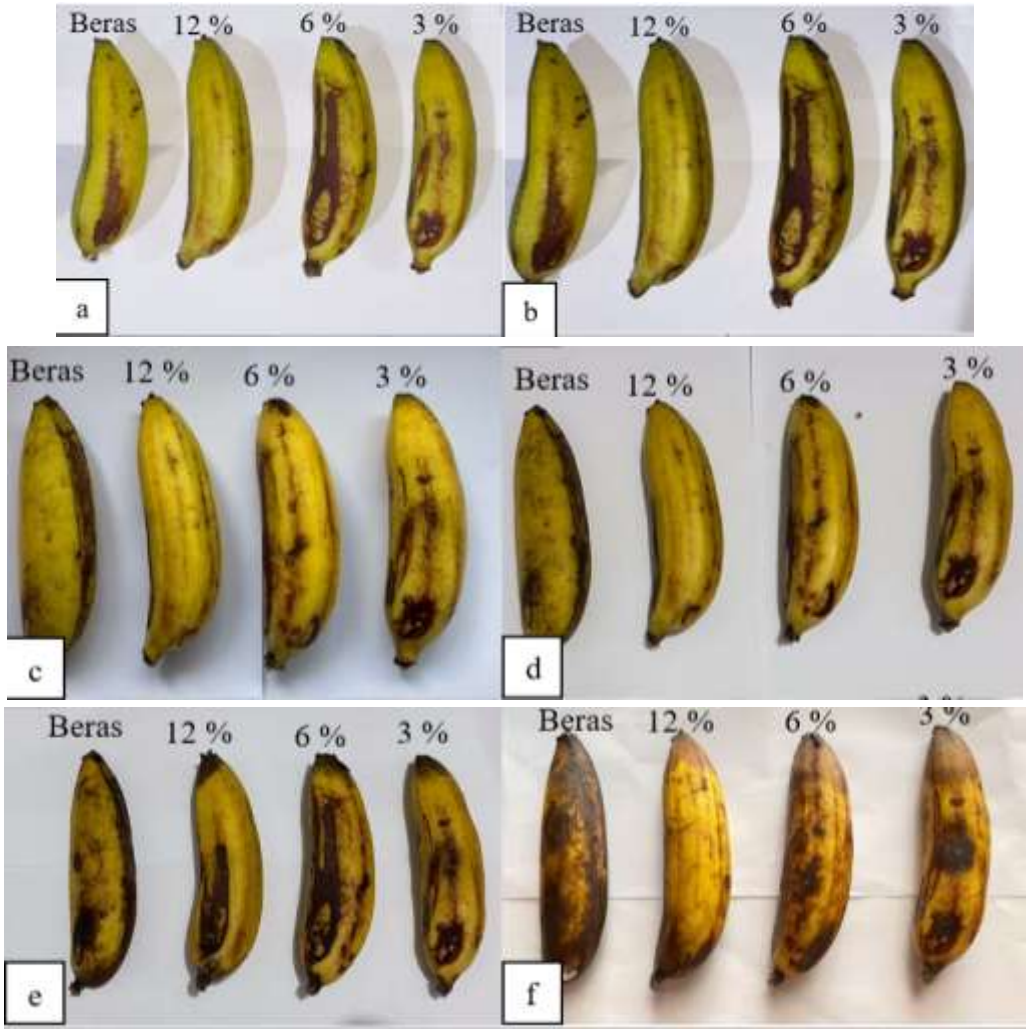

Figure 1. The ripening of bananas (*Musa Paradisiaca var. Sapientum*): a. Day one; b. Day two; c. Day three; d. Day four; e. Day five; f. Day six.

Banana Ambon at different concentrations affects the physiological changes of the fruit. In this study, it was found that at a concentration of 12 %, the fruit ripened quickly, whereas at a 3% concentration, the rate of fruit ripening was slower. This can be seen in the brown color and soft texture at 12% concentration. In contrast, at 3% concentration, the banana on day six was yellow-brown and had a soft texture. This is because the higher the concentration of calcium carbide, the more the color changes, which means that the fruit ripening process is faster. In contrast, the provision of low concentrations causes the production of ethylene hormones to be low (Firmansyah et al., 2022). Fruit ripening occurs because of the rate of respiration, which increases the hormone ethylene. Respiration breaks down complex materials into simple molecules and is a good indicator of cellular metabolism (Maduwanthi and Marapana, 2019). The ethylene hormone works by reducing the chlorophyll in the fruit and increasing the production of carotenoids and anthocyanins, causing the color of the fruit to change from green to yellow or brown (Iqbal et al., 2017). Changes in banana texture are caused by ethylene hormones adhering to parenchyma cells and changing their mechanism of action to create gaps between parenchyma cells. The gaps formed can change the structure of the cell wall, resulting in fruit softening. In addition, polygalacturonase, pectin methylesterase, pectate lyase, β-galactosidase, cellulase, and hydrolytic proteins play a role in the fruit softening process (Paniagua et al., 2014). Changes in flavor are caused by the hydrolysis process, which produces volatile compounds that give the fruit its characteristic aroma (Suryanti et al., 2017). The volatiles produced are ester compounds and short-chain fatty acids from ripe fruit.

Changes in color, texture, and flavor are also influenced by the transpiration process, which is the loss of water content from the fruit, affecting the appearance of color, texture, flavor, loss of fruit weight, and fruit moisture (Khafid et al., 2023; Sidabalok et al., 2023). In general, the fruit loses 5% to 10% of its initial water content during ripening, resulting in a decrease in fruit quality, causing the fruit to wilt and shrivel (Lufu et al., 2020). The process of transpiration in fruit is observable, but the mechanism of water content reduction is influenced by various physiological and biochemical factors, as well as post-harvest treatments and handling (Khafid et al., 2023; Lufu

et al., 2020). Additionally, the rate of fruit maturity is influenced significantly by temperature and storage duration. Bananas stored at room temperature exhibit increased respiration rates, causing faster ripening. The duration of the ripening process ultimately determines the quality of the bananas produced.

The following results were obtained in the organoleptic test using the variables of color, texture and aroma for the 40 panelists:

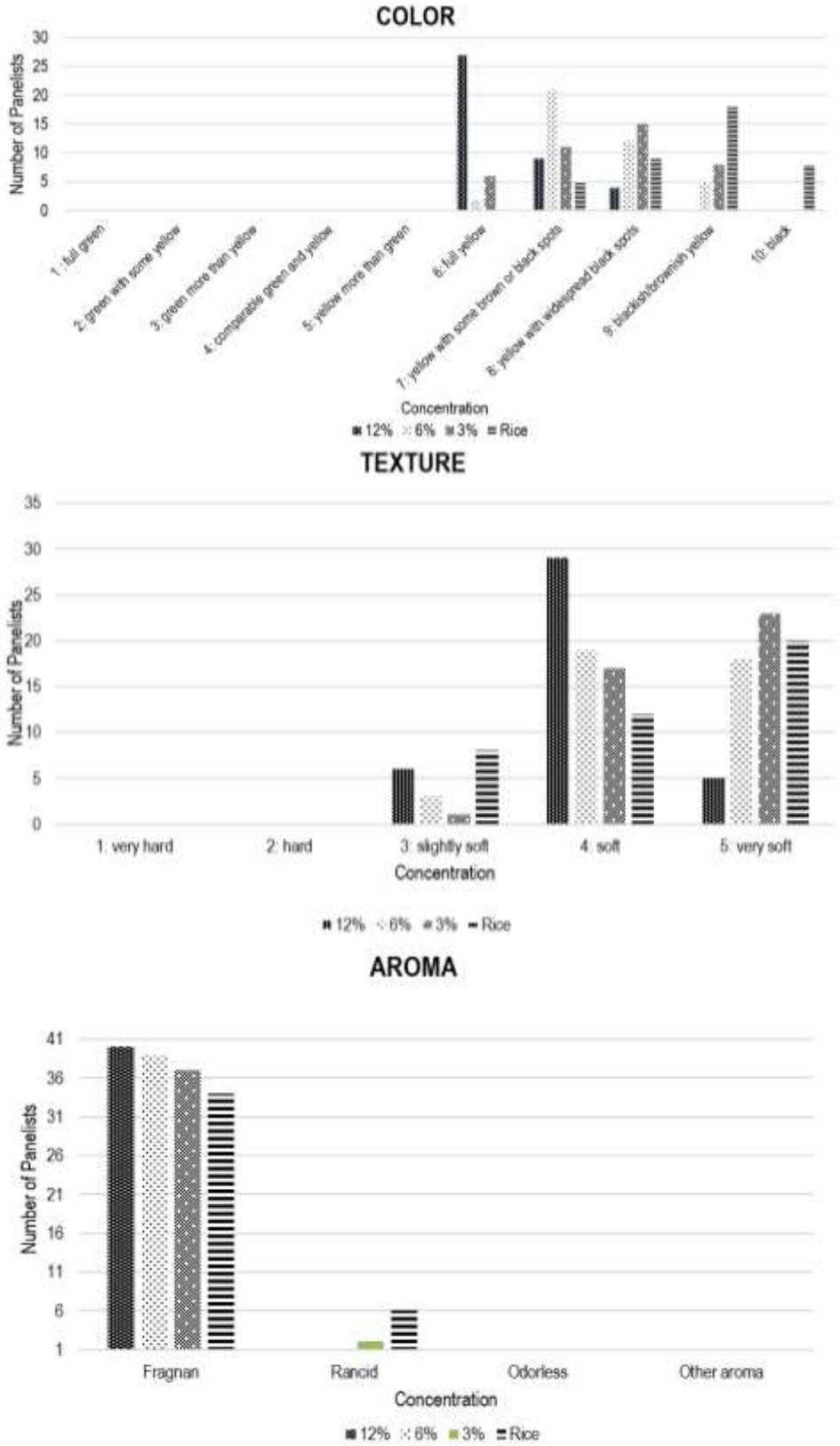

Figure 2. Organoleptic test of banana ripening with parameters of color, texture, and aroma.

Organoleptic tests were performed on the sixth day after the end of the observation period. Based on the above data, the results obtained were divided into three diagrams: color, texture, and aroma diagrams. The color

parameter showed that the panelists liked the full yellow color at 12%, whereas at a concentration of 6%, the banana was yellow with a few black spots. At a concentration of 3%, the banana was yellow with increasingly widespread black spots. The texture parameter showed that most panelists chose a soft texture at concentrations of 12%, 6%, and 3%, with 29, 19, and 17 panelists, respectively. In contrast, a small number of panelists chose a slightly soft texture at all three concentrations. The aroma parameters showed that panelists liked bananas with a fragrant aroma. This is shown in the graph with the average number of panelists who chose a fragrant aroma: 40 panelists for the 12% concentration, 39 panelists for the 6% concentration, and 37 panelists for the 3% concentration. In the control rice ripening, the color parameter showed a difference in the level of panelist preference. The texture parameter showed the banana was soft, whereas the flavor parameter did not differ significantly among the three calcium carbide concentrations. The table above shows that, at a concentration of 12%, the panelists liked the yellow color because of its attractive appearance. Color is an important parameter influencing consumers' decision to choose banana fruits (Damayanti et al, 2023). The color of banana skin provides information on the degree of ripening and freshness of bananas (Indarto et al., 2017).

CONCLUSION

Based on these results, it can be concluded that using calcium carbide increased the rate of fruit ripening. The fruit ripening process can be observed using variables of color, texture, and aroma. The faster the ripening process of bananas, the greater the satisfaction of consumer needs in the market. This results in the amount of banana production in Indonesia being in line with the amount of banana consumption.

REFERENCES

Akter, B., Talukder, N., Bari, L., & Rabeta, M. S. (2020). Evaluation of ripening period, shelf-life, and physiological properties of Sobri (*Musa cavendish*) and Sagor (Musa oranta) bananas triggered by ethephon and calcium carbide. *Food Research*, 4(2), 407-412. https://doi.org/10.26656/fr.2017.4(2).290

Arif, A. Bin, Diyono, W., Syaefullah, E., Suyanti, & Setyadjit. (2014). Optimalisasi cara pemeraman buah cempedak (*Artocarpus champeden*). *Journal Infromatika Pertanian*, 23, 35-46.

Brizzolara, S., Manganaris, G. A., Fotopoulos, V., Watkins, C. B., & Tonutti, P. (2020). Primary metabolism in fresh fruits during storage. *Frontiers in Plant Science*, 11, 1–16. https://doi.org/10.3389/fpls.2020.00080

Damayanti, A., Karsiningsih, E., & Muntoro, M. (2023). Analysis of attitude and consumer preferences to purchase decisions of banana fruit in traditional markets Pangkalpinang City. *JIA (Jurnal Ilmiah Agribisnis): Jurnal Agribisnis Dan Ilmu Sosial Ekonomi Pertanian*, 8(1), 65–72. https://doi.org/10.37149/jia.v8i1.428

Firmansyah, Sabahannur, & Alimudin, S. (2022). Uji dosis karbid (CaC_2) dan jenis kemasan terhadap waktu pematangan dan mutu buah pisang raja bulu (*Musa paradisiaca L. var sapientum*). *Jurnal AGrotekMAS,* 3(3), 9-19.

Hapsari, L., & Lestari, D. A. (2016). Fruit characteristic and nutrient values of four Indonesian banana cultivars (Musa spp.) at different genomic groups. *Agrivita*, 38(3), 303–311. https://doi.org/10.17503/agrivita.v38i3.696

Harto, A. B., Prastiwi, P. A. D., Ariadji, F. N., Suwardhi, D., Dwivany, F. M., Nuarsa, I. W., & Wikantika, K. (2019). Identification of banana plants from unmanned aerial vehicles (UAV) photos using object based image analysis (OBIA) method (a case study in Sayang Village, Jatinangor District, West Java). *HAYATI Journal of Biosciences*, 26(1), 7–14. https://doi.org/10.4308/hjb.26.1.7

Hasanah, R., Daningsih, E., & Titin. (2017). The analysis of nutrient and fiber content of banana (*Musa paradisiaca*) sold in Pontianak, Indonesia. *Biofarmasi Journal of Natural Product Biochemistry*, 15(1), 21–25. https://doi.org/10.13057/biofar/f150104

Hastuti, Purnomo, Sumardi, I., & Daryono, B. S. (2019). Diversity wild banana species (*Musa spp.*) in Sulawesi, Indonesia. *Biodiversitas*, 20(3), 824–832. https://doi.org/10.13057/biodiv/d200328

Indarto, & Murinto. (2017). Deteksi kematangan buah pisang berdasarkan fitur warna citra kulit pisang menggunakan metode transformasi ruang warna HIS (Banana fruit detection based on banana skin image features using HSI color space transformation method). *Jurnal Ilmiah Informatika*, 5, 15–21.

Iqbal, N., Khan, N. A., Ferrante, A., Trivellini, A., Francini, A., & Khan, M. I. R. (2017). Ethylene role in plant growth, development and senescence: interaction with other phytohormones. *Frontiers in Plant Science*, 8, 1–19. https://doi.org/10.3389/fpls.2017.00475

Kemenko Perekonomian RI. (2022). *Terus dorong peningkatan konsumsi buah nusantara, pemerintah gelar kembali gelar buah nusantara (GBN) ke-7 Tahun 2022. Ekon.Go.Id, HM.4.6/435/SET.M.EKON.3/08/2022*. Kemenko Perekonomian RI. from https://www.ekon.go.id/publikasi/detail/4450/terus-dorong-peningkatan-konsumsi-buah-nusantara-pemerintah-gelar-kembali-gelar-buah-nusantara-gbn-ke-7-tahun-2022

Khafid, A., Nurchayati, Y., Hastuti, E. D., & Setiari, N. (2023). Vitamin C and total soluble solid content of crystal

guava at different storage duration and ripeness. *Kultivasi*, 22(2), 147–156. https://doi.org/10.24198/kultivasi.v22i2.44124
Kuang, J. F., Wu, C. J., Guo, Y. F., Walther, D., Shan, W., Chen, J. Y., Lu, W. J. (2021). Deciphering transcriptional regulators of banana fruit ripening by regulatory network analysis. *Plant Biotechnology Journal*, 19(3), 477–489. https://doi.org/10.1111/pbi.13477
Lufu, R., Ambaw, A., & Opara, U. L. (2020). Water loss of fresh fruit: Influencing pre-harvest, harvest and postharvest factors. *Scientia Horticulturae*, 272(May). https://doi.org/10.1016/j.scienta.2020.109519
Maduwanthi, S. D. T., & Marapana, R. A. U. J. (2019). Induced ripening agents and their effect on fruit quality of banana. *International Journal of Food Science*, 2019. https://doi.org/10.1155/2019/2520179
Markiah, Hustiany, R., & Rahmi, A. (2020). Upaya Mempertahankan Umur Simpan Pisang Kepok Dengan Kemasan Aktif Berbahan Arang Aktif Cangkang Kelapa Sawit. *Jurnal Teknologi Industri Pertanian*, 30(2), 198–208. https://doi.org/10.24961/j.tek.ind.pert.2020.30.2.198
Oladipupo, A. R., Akinleye, M. O., & Coker, H. A. B. (2022). The use of calcium carbide in fruit ripening: Health risks and arsenic index as a quantitative marker for calcium carbide residue. *Progress in Chemical and Biochemical Research*, 5(2), 125–132.
Paniagua, C., Posé, S., Morris, V. J., Kirby, A. R., Quesada, M. A., & Mercado, J. A. (2014). Fruit softening and pectin disassembly: An overview of nanostructural pectin modifications assessed by atomic force microscopy. *Annals of Botany*, 114(6), 1375–1383. https://doi.org/10.1093/aob/mcu149
Putri, R. A. (2023). Induksi ethepon dan metanol pada pematangan buah pisang Ambon (*Musa acuminata Colla*) berdasarkan kandungan glukosa dan protein. Universitas Lampung. pp. 1-30.
Rachma, Y. A., Andila, R., & Ardianto, C. (2022). Character of Banana var.Raja (*Musa paradisiaca L.*) at Different Storage Conditions. *Jurnal Agrifoodtech*, 1(1), 54.
Riandini, E., Astuti, R. R. S., & Setiawan, M. R. (2021). Jenis-Jenis pisang (Musaceae) di Kecamatan Curup Tengah Kabupaten Rejang Lebong (Types of Banana (Musaceae) in Curup Tengah District, Rejang Lebong Regency). *Biologica Samudra*, 3(1), 14–24.
Saiya, H. G., Hiariej, A., Pesik, A., Kaya, E., Hehanussa, M. L., & Putuhu, F. (2020). Dispersion of tongka langit banana in buru and seram, maluku province, indonesia, based on topographic and climate factors. *Biodiversitas*, 21(5), 2035–2046. https://doi.org/10.13057/biodiv/d210529
Salas-Pascual, M., & Cáceres-Lorenzo, T. (2022). The dispersal of bananas (*Musa spp.*) to the Americas in the sixteenth century. *Economic Botany*, 76(4), 354–367. https://doi.org/10.1007/s12231-022-09559-2
Seyedabadi, E., Khojastehpour, M., & Abbaspour-Fard, M. H. (2019). Online measuring of quality changes of banana slabs during convective drying. *Engineering in Agriculture, Environment and Food*, 12(1), 111–117. https://doi.org/10.1016/j.eaef.2018.10.004
Sidabalok, I., Fitria, E. A., Susanto, A., & Karina, I. (2023). Application of Edible Coating Breadfruit Starch Against Cayenne Pepper (*Capsicum frustescens*) Storage at Room Temperature. *Jurnal Teknologi Industri Pertanian*, 33(1), 72–78. https://doi.org/10.24961/j.tek.ind.pert.2023.33.1.72
Strobl, E., & Mohan, P. (2020). Climate and the global spread and impact of Bananas' Black Leaf Sigatoka disease. *Atmosphere*, 11(9), 1–19. https://doi.org/10.3390/ATMOS11090947
Sulistyaningsih, L. D. (2016). The diversity of wild banana species (Genus Musa) in Java. *Makara Journal of Science*, 20(1). https://doi.org/10.7454/mss.v20i1.5660
Suryanti, S. D., Apriyanto, M., & Nadia, L. S. (2017). Pengaruh lama pemeraman dan jenis kertas pembungkus terhadap kualitas sifat organoleptik dan kimia buah pisang Ambon (*Musa paradisiaca var. sapientum L*). *Jurnal Teknologi Pertanian*, 6(1), 26–37. https://doi.org/10.32520/jtp.v6i1.99
Van den houwe, I., Chase, R., Sardos, J., Ruas, M., Kempenaers, E., Guignon, V., & Roux, N. (2020). Safeguarding and using global banana diversity: a holistic approach. *CABI Agriculture and Bioscience*, 1(1), 1–22. https://doi.org/10.1186/s43170-020-00015-6
Warella, J. C. (2023). Organoleptic test of eco-enzyme : Fermentation of banana peel waste. *Bioma : Jurnal Ilmiah Biologi*, 12(1), 44–53. https://doi.org/10.26877/bioma.v12i1.14803
Wekti, C. W. K., Khanifah, F. (2018). Kadar vitamin C Pada buah pisang raja (*Musa paradisiaca* L) sebelum dan sesudah penambahan kalsium karbida (CaC2). *Jurnal Insan Cendekia*. 6(1), 13-17.