Effects of Gibberellin (GA$_3$) Concentration on the Quality of White Java Plum (Syzygium cumini)

Muhammad Muharram$^1$, Satria Bayu Aji$^2$, Tjatur Prijo Rahardjo$^3$, Supandji$^4$

$^{1,2,3,4}$Faculty of Agriculture, Kadiri University, Indonesia.

Email: $^1$mumu@unik-kediri.ac.id

Abstract. White Java plum (Syzygium cumini) is a native plant of Indo-Malaysia, which has been only infrequently in the wild and even more rarely when cultivated. That is because the quality of java plum fruit is very low, and hence affecting society's demand for the fruit. This study aimed to determine the quality improvement of white java plum fruit due to the induction of gibberellins. There were several fruit quality parameters applied in the study, including seed size, fruit size, the weight of seeds and fruit, thick fruit flesh, and sugar content in fruit. The study was conducted at Kadiri University, Kediri City, East Java, in August-September 2019. The experiment employed a Completely Randomized Design with a single factor, which was the induction of gibberellins with 5 levels of concentration (0, 25, 50, 75, and 100 ppm) and 6 replications. The white java plum tree utilized as an experimental sample was 10 years old. The results showed that the induction of gibberellins at a concentration level of 75 ppm was able to improve the quality of the white java plum, in spite of the fact that, on average, the parameters were not significantly different from the concentration of 100 ppm.

Keywords: Fruit Quality, Gibberellins, White Javaplum,$^\circ$Brix.

1. Introduction

Juwet also known as jamblang or duwet (Syzygium cumini(L.) Skeels) is a native plant of Indonesia which is rich in essential oils, tannins, flavonoids, and anthocyanins [1], [2], [3], [4]. The empirical use of S. cumini has been widely used by the general public for traditional medicine. Preclinical studies show that the stems, leaves and fruit of juwet plants contains antioxidant, anti-inflammatory, anthelmintic, anticancer, antibacterial, and antidiabetic activities [5]. According to many studies, the benefits of the plant are well known, but public interest in juwet fruit is still quite low, due to fruit low quality.

Aspect parameters of fruit quality are numerous, covering the taste, color, and thickness of fruit flesh that can be consumed. The quality of fruit is characterized by various attributes, both from inside and outside. Points that indicate the quality of fruit from the inside are sweetness, acidity, aroma, vitality, and nutritional value, while from the outside are the fruit size, color, and texture. Juwet fruit has huge seeds. Thus the flesh of the fruit that can be consumed is relatively small. In addition, the shape of the juwetfruit moderately is unattractive because most of the bottom parts of the fruit are slightly curved so that the juwet looks bent. Fruit size is very dependent on the composition of the growth regulator between gibberellins and auxins, which gibberellins have a significant effect on fruit thickness [1].

The application of gibberellins at the time of flowering is known to cause a parthenocarpy event. Parthenocarpy is an important character for industry because the seeds do not have to be
removed before processing [6], [7]. This is due to the administration of gibberellins can cause sterile seeds or no seed formation [8]. The same effect is also explained in rice plants [9]. The low number of seeds per panicle causes the weight of seeds per panicle so that the administration of gibberellins should be carried out after flowering stage [10]. The results of gibberellins induction have a larger cell size, although with a smaller number of cells compared to polarized fruit [11]. Gibberellins has been known to be capable increase fruit set and tomato yield on low concentration [12], [13]. Gibberellins are known as triggers growth which has an influence broad for plants, especially in cell division and cell enlargement [14], [15].

2. Research Method

This research was conducted at the Kadiri University, Kediri City, East Java. The experiment was conducted at the time the plants were flowering, ie from September to November 2019. This research was compiled using a factorial completely randomized design (CRD) with 6 replications. There are two factors in this research, namely the concentration of GA. (0, 25, 50, 75 and 100 ppm). Data taken included fruit size (diameter and length), weight of fruit flesh, seed size (diameter and length), weight of seeds, and the measurement of harvested fruit sugar content (°Brix) by using the Atago, a Japanese hand refractometer. The data obtained then be analyzed by using analysis of variance or the DSAASTAT ver. 1.101 software, the results of significantly different tests will then be further tested with the Duncan test with a level of 5%.

3. Results and Discussion

The results showed that the induction of the gibberellins hormone can improve the quality of white juwet fruit, which is presented in table 1. Table 1 shows that the average length, diameter and weight of white juwet seeds in the treatment without gibberellins have a higher value than those induced with gibberellins. The length parameter of white juwet seeds ranged from an average of 2.14 to 2.49 cm, with the highest seed length was discovered at 0 ppm concentration and was significantly different from other concentrations. The average diameter of white juwet seeds ranges from 0.94 to 1.19 cm, with the highest seed diameter is owned by 50 ppm treatment, but not significantly different from the treatment of 0 and 25 ppm. Length and diameter development of juwet seed in Table 1 indicated that the size of the seed at a concentration of 0 ppm presenting the highest results and showed normal size of a ripe of white Duwet fruit seed at harvest. Mean while the 75 and 100 ppm concentration showed a lower length and diameter. The low length and diameter of the seeds and the unstable growth of the gibberellins treatment explained that gibberellins affected the seed development.

Weight parameter of white juwet seeds showed an average value of 1.43 to 1.67 cm, with the highest seed weight was indicated by 25 ppm concentration and was not significantly different from concentration 0, 50, and 100 ppm. The data in table 1 does not indicate that gibberellins do not significantly affect the weight of seeds. Despite affecting seed size development, gibberellins do not affect the seed weight. This can be interpreted that although the size does not develop normally, but the embryo and endosperm still develop. Data from the analysis of variance showed that the treatment of gibberellins induction on juwet fruit had a significant influence on the parameters of fruit length, fruit diameter, fruit weight, meat thickness, and sugar content (°Brix). Average length of white juwet fruit ranged from the concentration 2.75 to 3.08 cm. 75 ppm concentration showed the highest fruit length and it was significantly different from treatment 0, 25, and 50 ppm, but not significantly different from 100 ppm concentration. Similarly, 75 ppm concentration had significantly different results with treatment concentrations of 0, 25, and 50 ppm and not significantly different from the concentration of 100 ppm. Permatasari [16], mentioned that gibberellins increases fruit size, and affects cell division (increase in number).
The increase in cell size causes an increase in the size of tissues, organs and eventually increase in the size of the whole plant body. Fatonah [17] research results, explained the growth of fruit associated with fruit sink strength, while the induction of gibberellins can increase the weight of melons due to increasing photosynthesis result. In accordance with the opinion of Wijayanto [18], the induction of gibberellins to the fruit will increase the weight of the fruit by the results of photosynthate. The ability of fruit to store assimilate yields increases the water content of the fruit and affects the weight of the fruit. Analysis of variance on fruit weight parameters showed that the treatment of gibberellins induction at a concentration level of 75 ppm showed the highest results of 10.22 g and was significantly different from concentrations of 0 and 25 ppm. The fruit thickness parameter showed that the concentration of 75 ppm has the highest yield of 0.65 cm and was significantly different with concentrations of 0, 25 and 50 ppm, yet was not significantly different from the concentration of 100 ppm. The fruit thickness parameter is an indicator of how much amount of fruit flesh can be consumed. Concentration of 75 ppm was in the parameters of sugar content.

### Table 1. Harvest variables

| GA , concentration (ppm) | Variable          | Seed length (cm) | Seed diameter (cm) | Seed Weight (g) | Fruit Length (cm) | Fruit diameter (cm) | Fruit Weight (g) | Fruit Thickness (cm) | °Brix |
|--------------------------|-------------------|------------------|--------------------|-----------------|-------------------|---------------------|-------------------|---------------------|-------|
| 0                        |                   | 2.49 b           | 1.19 b             | 1.66 b          | 2.75 a            | 2.13 a              | 7.47 a            | 0.43 a              | 13.50 a |
| 25                       |                   | 2.21 a           | 1.18 b             | 1.67 b          | 2.78 a            | 2.13 a              | 7.80 a            | 0.48 a              | 15.50 ab |
| 50                       |                   | 2.19 a           | 1.18 b             | 1.62 b          | 2.82 a            | 2.20 a              | 8.90 ab           | 0.51 ab              | 17.17 ab |
| 75                       |                   | 2.14 a           | 0.99 a             | 1.43 a          | 3.08 b            | 2.53 b              | 10.22 b           | 0.65 c              | 21.67 b |
| 100                      |                   | 2.14 a           | 0.94 a             | 1.53 ab         | 3.00 b            | 2.32 ab             | 8.97 ab           | 0.60 bc             | 20.17 b |

Note: The numbers followed by the same letters in the same column are not significantly different based on the 5% Duncan test.
(°Brix) also showed the highest results of 21.67 (°Brix) and significantly different from the concentration of 0 ppm. Setiawan [1], reported that black juwet has a sugar content ranging from 12.5-16.5 °Brix.

Basically, fruit and seeds develop simultaneously. However, Widodo [19], stated that seeds are a determining factor for growth, size, shape, sugar content and fruit acids. Naturally formed hormones are in formed the seeds, and then are transplanted into fruit walls and regulate cell division and enlargement. Setiawan [20] also explained. Parthenocarpy fruit has decreased in size (length, diameter, and thickness of the flesh) and decreased yield of tomatoes compared to seed fruit. According to research results, gibberellin hormones are able to inhibit the growth of white juwat seeds, but it has no effect on fruit growth. During the experiment, gibberellins were induced twice. In the first induction it was induced to inhibit the seeds, while the second induction aimed to replace the function of the seeds for fruit development.

4. Conclusion
Gibberellin induction treatment with different concentrations in white juwat fruit significantly affected the whole observed parameters. Gibberellin induction in the concentration level of 75 ppm showed the best results, in spite of the on average the result was not significantly different from the concentration of 100 ppm. Gibberellin hormones are able to inhibit the growth of white juwat seeds, but it has no effect on fruit growth.

5. Acknowledgments
The researcher wants to support Kadiri University, especially the Agriculture Faculty, for giving a chance for doing the research and composing the report.

References
[1] E. Setiawan, "Effect Bagging Treatment to Quality of Black Plum Fruit," *Agrovigor J. Agroekoteknologi*, vol. 11, no. 2, pp. 83–87, 2018.
[2] H. R., J. S., and F. K. Arshad, "Comparative analysis of antioxidant profiles of bark, leaves dan seeds of syzigiumcumini (Indian blacberry)," *J. IJR*, vol. 3, 2015.
[3] J. M. Veigas, M. S. Narayan, P. M. Laxman, and B. Neelwarne, "Chemical nature, stability and bioefficacies of anthocyanins from fruit peel of syzygium cuminii Skeels," *Food Chem.*, vol. 105, no. 2, pp. 619–627, 2007.
[4] M. S. Baliga, H. P. Bhat, B. R. V. Baliga, R. Wilson, and P. L. Palatty, "Phytochemistry, traditional uses and pharmacology of Eugenia jambolana Lam. (black plum): A review," *Food Res. Int.*, vol. 44, no. 7, pp. 1776–1789, 2011.
[5] R. S. B. Eshwarappa, R. S. Iyer, S. R. Subbaramaiah, S. A. Richard, and B. L. Dhananjaya, "Antioxidant activity of Syzygium cumini leaf gall extracts," *BioImpacts*, vol. 4, no. 2, pp. 101–107, 2014, doi: 10.5681/bi.2014.018.
[6] G. L. Rotino *et al.*, "Open field trial of genetically modified parthenocarpic tomato: Seedlessness and fruit quality," *BMC Biotechnol.*, vol. 5, pp. 1–8, 2005.
[7] S. Sato, M. M. Peet, and R. G. Gardner, "Altered flower retention and developmental patterns in nine tomato cultivars under elevated temperature," *Sci. Hortic. (Amsterdam).*., vol. 101, no. 1–2, pp. 95–101, 2004.
[8] T. L. and Z. E., *Plant Physiology*, 3rd Ed. Sunderland: Sinauer Associates, 2002.
[9] Yang Liu, "Effect of Gibberellic acid (GA3) and α-naphthalene acetic acid (NAA) on the growth of unproductive tillers and the grain yield of rice (Oryza sativa L.)," *African J. Agric. Research*, vol. 7, no. 4, pp. 534–539, 2012.
[10] F. Y. · Wicakseno, T. Nurmalra, A. W. Irwan, and A. S. U. Putri, "The effect of gibberellins and cytokinins concentration on growth and yield of wheat (Triticumaestivum L.) on medium land Jatinangor," *J. Cultiv.*, vol. 15, no. 1, pp. 52–58, 2016.
[11] J. C. Serrani, M. Fos, A. Atarés, and J. L. García-Martínez, "Effect of gibberellin and auxin on
parthenocarpic fruit growth induction in the cv Micro-Tom of tomato,” *J. Plant Growth Regul.*, vol. 26, no. 3, pp. 211–221, 2007.

[12] H. Sasaki, T. Yano, and A. Yamasaki, “Reduction of high temperature inhibition in tomato fruit set by plant growth regulators,” *Japan Agric. Res. Q.*, vol. 39, no. 2, pp. 135–138, 2005, doi: 10.6090/jarq.39.135.

[13] M. M. A. Khan, C. Gautam, F. Mohammad, M. H. Siddiqui, M. Naeem, and M. N. Khan, “Effect of gibberellic acid spray on performance of tomato,” *Turkish J. Biol.*, vol. 30, no. 1, pp. 11–16, 2006.

[14] D. E. Richards, K. E. King, T. Ait-ali, and N. P. Harberd, “A Molecular Genetic Analysis of Gibberellin Signaling,” *Annu. Rev. Plant Physiol. Plant Mol. Biol.*, vol. 52, pp. 67–88, 2001.

[15] M. Matsuoka, “Gibberelin Signaling: How Do Plant Cells Respond to GA signals,” *J. Plant Growth Regul.*, vol. 22, no. 2, pp. 123–125, 2003.

[16] D. A. Permatasari, Y. S. Rahayu, and E. Ratnasari, “Effect of Gibberellin Hormones on The Formation of Parthenocarpy Fruit of Tomato Plants Varieties Tombatu F1,” *LenteraBio*, vol. 5, pp. 25–31, 2016.

[17] S. Fatonah, M. Kasim, and A. Syarif, “Increased Sink Capacity in Melon (Cucumis melo L.) Plants by Providing Gibberellins,” *SAGU*, vol. 8, no. 2, pp. 38–43, 2009.

[18] T. Wijayanto, W. O. R. Yani, and M. W. Arsana, “Response of Yield and Seed Number of Watermelon (Citrullus vulgaris) Treated with Hormone Gibberellin (GA3),” *J. Agroteknos*, vol. 2, no. 1, pp. 2087–7706, 2012.

[19] W. D. Widodo, “Endogenous Hormone Activity in Young Seedless Berry of Muscat of Alexandria Grapes Induced by Antibiotics,” *Indones. J. Agron.*, vol. 30, no. 3, pp. 92–99, 2002.

[20] A. B. Setiawan, R. H. Murti, and A. Purwantoro, “The Effect of Gibberellin on Parthenocarpic Fruit Morphology and Yield of Seven Tomato Genotypes (Solanumlycopersicum L.),” *Agric. Sci.*, vol. 18, no. 2, pp. 69–76, 2015.