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ROOT INDUCTION OF BORNEO PRIMA TANGERINE (*Citrus reticulata*) BY *IN VITRO* METHOD USING NATURAL PLANT GROWTH REGULATOR *RAJA* BANANA (*Musa Paradisiaca* Var. Raja) AND SYNTHETIC NAPHTHALENE ACETIC ACID (NAA)

INDUKSI PERAKARAN TANAMAN JERUK KEPROK BORNEO PRIMA (*Citrus Reticulata*) SECARA *IN VITRO* DENGAN PENAMBAHAN ZAT PENGATUR TUMBUH ALAMI PISANG RAJA (*Musa Paradisiaca* Var. Raja) DAN SINTETIK NAPHTHALENE ACETIC ACID (NAA)

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Abstract

Borneo prima tangerine (*Citrus reticulata*) is a plant species from East Kalimantan, which is expected to become one of the leading citrus in the country. The obstacle to developing this citrus is that cultivation is still limited, so efforts are needed to cultivate plants using *in vitro* techniques. The process of plant multiplication has been done, the next step is rooting. The purpose of this research is to know the type and concentration of plant growth regulators (PGR) that are optimal in stimulating root growth in Borneo prima tangerine plants. This study used a completely randomized design consisting of 9 treatments, namely control (without the addition of PGR), the addition of natural PGR *raja* banana extract with concentrations of 25; 50; 75; and 100 g/L, synthetic PGR Naphthalene Acetic Acid (NAA) concentrations of 0.5; 1.0; 1.5; and 2.0 mg/L, each treatment with 3 replicates. The results showed the addition of *raja* banana extract 75 g/L produced the fastest root emergence time of 3.33 days, the addition of NAA 0.5 mg/L produced the highest number of roots, namely 4.67 roots, and plantain extract 50 g/L produced the longest roots, namely 4.50 cm. This means that the addition of *raja* banana extract gives the best results in inducing root formation.

Keywords: Borneo prima tangerine; *In vitro*; Plant growth regulator; Rooting

Abstrak

Abstrak

Jeruk keprok borneo prima (Citrus reticulata) adalah jeruk yang berasal dari Kalimantan Timur, yang diharapkan menjadi salah satu jeruk unggulan dalam negeri. Kendala pengembaangan jeruk ini adalah jumlah tanaman yang masih terbatas, sehingga diperlukan upaya budi daya tanaman menggunakan teknik in vitro. Proses multiplikasi tanaman telah dilakukan, langkah berikutnya adalah perakaran. Penelitian bertujuan mengetahui konsentrasi zat pengatur tumbuh (ZPT) yang optimal dalam merangsang pembentukan akar jeruk keprok borneo prima secara in vitro. Penelitian ini menggunakan rancangan acak lengkap yang terdiri atas 9 perlakuan, yaitu kontrol (tanpa penambahan ZPT), penambahan ZPT alami ekstrak pisang raja dengan konsentrasi 25; 50; 75; dan 100 g/L, ZPT sintetik Naphthalene Acetic Acid (NAA) konsentrasi 0,5; 1,0; 1,5; dan 2,0 mg/L, setiap perlakuan dengan 3 ulangan. Hasil penelitian menunjukkan penambahan ekstrak pisang raja 75 g/L menghasilkan waktu muncul akar tercepat 3,33 hari, penambahan NAA 0,5 mg/L menghasilkan jumlah akar terbanyak, yaitu 4,67 akar, dan ekstrak pisang raja 50 g/L menghasilkan akar terpanjang, yaitu 4,50 cm. Hal ini berarti bahwa penambahan ekstrak pisang raja 75 g/L memberikan hasil terbaik dalam menginduksi pembentukan akar.

***Kata Kunci**: In vitro; Jeruk keprok borneo prima; Perakaran; Zat pengatur tumbuh*

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INTRODUCTION

Oranges fruit are belong to the *Rutaceae* family and often consumed fresh (Tuasamu, 2018). Rich in vitamin C, oranges support the fight against free radicals and have the potential to prevent various diseases such as cancer and heart problems (Fitriana & Fitri, 2020). The demand for oranges continues to rise due to population growth, increased income, and interest in quality fruits. However, local production of citrus fruits is still insufficient, so Indonesia has to import from abroad. Therefore, government action is required to improve the quality of local oranges and promote the cultivation of local varieties that have the potential to compete with imported oranges (Rahayu & Poerwanto, 2014).

In 2007, the Ministry of Agriculture Indonesia introduced a new type of tangerine called Borneo prima (*Citrus reticulata* cv. Borneo Prima). The Borneo prima tangerine has become a leading horticultural crop in East Kalimantan, especially in the Rantau Pulung District, East Kutai Regency. The uniqueness of the Borneo prima tangerine is its ability to thrive in lowland areas, its easy-to-peel skin, and its lack of bitterness (Widyawati, 2017). Additionally, this tangerine has a long shelf life, an attractive appearance with a contrasting orange-green color, a refreshing sweet taste, and high productivity (Hamidah, 2018).

Increasing the production of high-quality local oranges like the Borneo prima tangerine has the potential to meet domestic demand and reduce dependence on imported oranges. Cultivation of Borneo prima tangerines is still limited to conventional propagation which often has many obstacles such as minimal availability of superior seeds and disease susceptibility. Therefore, an efficient cultivation method is needed to increase the number of Borneo prima tangerine plants quickly and free from disease. One of the procedures to propagate these plants is through tissue culture methods (Tuwo et al., 2022). The advantage of the tissue culture technique is its ability to produce high-quality plants, free from disease, and the ability to produce many plants in large quantities with genetic traits identical to the parent (Loi et al., 2020), efficient space use as it does not require large areas (Cokrowati et al., 2020), ensuring genetic consistency, a sterile environment, precise plant selection, careful environmental control, and the preservation of genetic diversity (Markal et al., 2015).

Propagation of Borneo prima tangerine plants by *in vitro* method has been successfully carried out by Habibah et al. (2021), where from different explant sources: apical buds, axillary buds, and stems, they succeeded in forming shoots in large numbers with the addition of BAP (6-benzyl amino purine). After the shoots are formed, the next step is root formation. Effective root induction ensures successful transplantation and optimal plant growth, while ensuring that the resulting plants have genetic traits identical to their parents (Cokrowati et al., 2020). Moreover, this method enables better control over growth conditions, including nutrition and environment, thereby enhancing the efficiency of producing healthy and robust roots (Thakur et al., 2024).

The proper selection of plant growth regulators (PGRs) is a crucial factor in the success of root induction (Handayani et al., 2020). PGRs, which are non-nutrient organic compounds, can stimulate, stop, or alter the course of plant growth and development when present in low concentrations (Kustiani, 2020). PGRs are divided into two types: natural and synthetic. Natural PGRs are those whose materials can be derived from plant parts. Examples of natural PGRs include sprout extract, shallot extract, and banana extract (Emilda, 2020). Synthetic PGRs are PGRs with low concentrations that can interact and balance endogenous PGRs, determining the direction of culture development (Satuhu et al., 2021). Synthetic PGRs are auxins, such as Naphthalene Acetic Acid (NAA), Indole Butyric Acid (IBA), 2,4 Dichlorophenoxyacetic Acid (2,4-D), cytokinin, gibberellin, and others (Astutik et al., 2021). Auxins play a role in stimulating shoot and root growth, inducing stem bending, promoting lateral root formation, and stimulating adventitious root growth (Dasuha, 2022).

The use of natural plant growth regulators (PGRs) such as banana extract is due to their content of natural auxins, which can promote root development (Aung et al., 2022). Synthetic PGRs such as Naphthalene Acetic Acid (NAA) are chosen for their strong ability to stimulate root formation and their reliable effects. NAA enables researchers to manage concentrations more accurately, leading to consistent outcomes in root growth of plants (Khandaker et al., 2017).

Research on the use of natural and synthetic PGRs in root stimulation has been conducted by several researchers. Ulfa and Isda (2020), found that NAA PGR at a concentration of 1.5 mg/L applied

to *Citrus nobilis* explants produced the best number of roots, which was 1.67 roots. According to research by Murkute et al. (2008), the application of NAA PGR at a concentration of 0.5 mg/L to *Citrus jambhiri* explants produced the best root length, which was 2.2 cm. Fajri et al. (2020) stated that *raja* banana extract at a concentration of 50 g/L applied to *Citrus aurantifolia* explants produced the best number of roots, which was 1.50 roots.

Research on the use of natural and synthetic PGRs on root growth of Borneo prima tangerine plants *in vitro* has not been attempted. Therefore, the purpose of this research was to determine the optimal concentration of PGR for stimulating root formation in Borneo prima tangerine plants.

MATERIALS AND METHODS

This research was conducted from December 2022 to April 2023 at the Tissue Culture Laboratory, Technical Implementation Unit of the Plantation Plant Protection Development Office (UPTD P2TP), Samarinda, East Kalimantan, Indonesia. This study used a completely randomized design (CRD) consisting of 9 treatments and each treatment was carried out 3 times with concentration levels, without PGRs (control), NAA (0.5; 1; 1.5; and 2 mg/L), *raja* banana extract (25; 50; 75; and 100 g/L).

Equipment Sterilization

Dissecting sets, petri dishes, beakers, and Erlenmeyer flasks are cleaned and dried. Equipment like dissecting sets and petri dishes are wrapped in a layer of HVS paper. These tools were sterilized using an autoclave at 121 °C for 15–20 minutes at 1 atmosphere (atm) pressure. Sterilized culture bottles are placed in a clean area, ready for use.

Preparation of Natural PGR (*Raja* Banana Extract) (Nurfadilah et al., 2018)

Raja banana extract is made by separating the fruit pulp from the skin and seeds. The ripe fruit pulp, which has a soft texture, is weighed in varying amounts: 25; 50; 75; and 100 g. Banana fruit is then blended to obtain banana extract. This extract is added to the treatment medium according to the desired concentration.

Preparation of Synthetic PGR (NAA) (Finna et al., 2015)

A stock solution of NAA with a concentration of 100 mg/L is prepared by weighing 10 mg of NAA and adding 100 mL of sterile distilled water into a 100 mL beaker. The PGR stock solution is transferred to a reagent bottle, tightly sealed with aluminum foil, labeled, and stored in a refrigerator.

Preparation of MS Stock Solution (Widasari et al., 2021)

The components of the MS medium are weighed and grouped according to their respective stocks, such as macronutrient stock, $CaCl_2.2H_2O$ stock, micronutrient stock, iron (Fe) stock, vitamin stock, and myo-inositol stock, using an analytical balance. Each nutrient stock is dissolved in distilled water using a magnetic stirrer until homogeneous in a beaker. The stock solutions are transferred to reagent bottles, covered with aluminum foil, labeled, and stored in a refrigerator.

Media Preparation (Widasari et al., 2021)

Media preparation involves filling a beaker with 500 mL of distilled water, then adding macronutrient stock solution, $CaCl_2.H_2O$ stock solution, micronutrient stock solution, iron (Fe) stock solution, vitamin stock solution, myo-inositol stock solution, and PGR stock solution according to the treatment. Next, 30 g of sugar is added to the solution and homogenized. The volume of the solution is then adjusted to 1000 mL, and the pH is measured using pH paper, with the optimal range being 5.6–5.8. If the solution is too alkaline, a few drops of HCl solution are added, and if too acidic, a few drops of NaOH solution are added until the desired pH is reached. Subsequently, 8 g of agar is added, and the solution is heated to a boil. The media is poured into culture bottles, sealed with PP plastic secured with rubber bands. Each bottle is labeled with the media name, concentration, and preparation date using label paper. The media is then sterilized using an autoclave at 121 °C for 15–

20 minutes at 1 atm pressure. The culture bottles are stored in the incubation room for 3 days to check for media contamination.

Preparation of Planting Area

The Laminar Air Flow Cabinet (LAFC) is cleaned with 95% alcohol. Equipment to be used in the planting process, such as tweezers, scalpels, bunsen burners, Petri dishes, and culture bottles, are placed in the LAFC after being sprayed with 95% alcohol. The ultraviolet (UV) lamp is turned on for 10–15 minutes before use.

Explant Planting

The explants are borneo prima tangerine plants (Figure 1). The explants used have a height of approximately ±2 cm. Each explant is planted upright into a bottle containing the treatment media. One explant is placed in each bottle. The bottles containing the explants are sealed with plastic and secured with rubber bands. Each culture bottle is labeled according to the treatment and planting date using label paper. The culture bottles are then placed on culture racks in the incubation room.

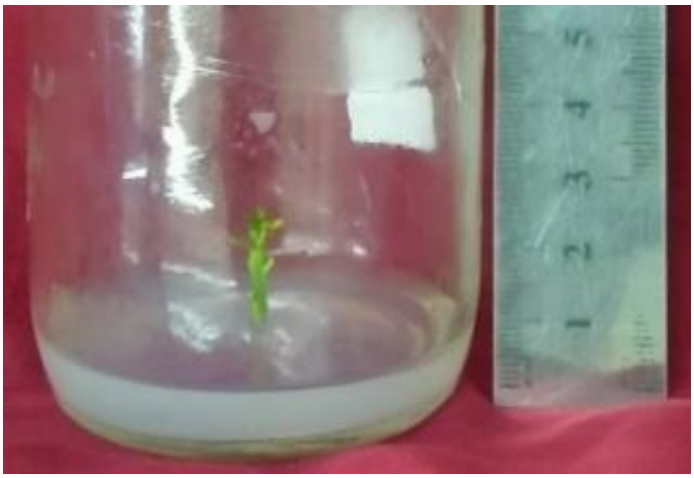

Figure 1. Borneo prima tangerine *in vitro* at 0 days after initiation

Explant Maintenance

The culture bottles must be kept clean and protected from contaminated media by spraying 70% alcohol. The incubation room conditions are maintained at a temperature of 20–24 °C, humidity of 80–99%, and light intensity of 700–1000 lux with 24-hour lighting.

Observation Parameters

Observations are made over 12 weeks after planting (WAP). The parameters include plant height increase (cm), number of leaves increase (leaves), root emergence time (days), number of roots, and root length (cm) produced in each treatment.

Data Analysis

Quantitative data obtained from observations will be analyzed using SPSS version 22. If there are significant differences between treatments, further tests using Duncan's Multiple Range Test (DMRT) will be conducted at a 95% significance level and if there are not significant differences between treatments, further tests using Man Whitney will be conducted at a 95% significance level.

RESULTS

Growth and Development of Borneo prima Tangerines Treated with Natural (*Raja* Banana Extract) and Synthetic (NAA) PGRs

One-way ANOVA analysis showed that the addition of *raja* banana extract and NAA affected the growth of plant height and number of leaves for 12 weeks after initiation (Table 1). Further testing using DMRT showed significant differences among treatment categories. The average plant growth height and number of leaves can be seen on Table 1.

Table 1. The effect of adding *raja* banana extract and NAA on the average increase in height and the increase in the number of leaves in Borne Prima tangerine plants for 12 weeks after initiation

Treatment	Observation parameters	
	Plant height increase (cm)	Increase in the number of leaves
Control	0.80 ± 0.15 [a]	6.00 ± 0.57 [abc]
NAA 0.5 mg/L	1.40 ± 0.21 [a]	8.67 ± 3.80 [a]
NAA 1.0 mg/L	0.67 ± 0.88 [ab]	4.67 ± 1.20 [abc]
NAA 1.5 mg/L	0.33 ± 0.88 [b]	2.00 ± 0.57 [ab]
NAA 2.0 mg/L	0.53 ± 0.88 [ab]	1.67 ± 1.20 [c]
Raja banana extract 20 g/L	0.83 ± 0.43 [a]	3.00 ± 1.50 [abc]
Raja banana extract 50 g/L	0.97 ± 0.12 [a]	4.00 ± 2.08 [abc]
Raja banana extract 75 g/L	1.90 ± 0.65 [a]	7.33 ± 0.88 [a]
Raja banana extract 100 g/L	0.67 ± 0.31 [ab]	3.00 ± 0.57 [abc]

Note: Numbers followed by different letters in the same column indicate a real difference in the DMRT test at the 95% significance level

Based on the results contained in Table 1, the addition of *raja* banana extract and NAA has a significant impact on the growth of plant height and the number of leaves of Borneo prima tangerine. The best treatment for increasing plant height growth is by using *raja* banana extract at a concentration of 75 g/L, to increase the number of leaves, the best treatment is to use NAA at a concentration of 0.5 mg/L. The addition of NAA at a concentration of 1.5 mg/L produced the lowest plant height growth and the addition of NAA at a concentration of 2.0 mg/L produced the lowest number of leaves.

Figure 2. The best plant height increase with *raja* banana extract treatment at 75 g/L at 12 weeks after initiation

Figure 3. The highest increase in the number of leaves with NAA treatment at 0.5 mg/L at 12 weeks after initiation

Raja banana extract and NAA had a significant impact on root emergence time, number of roots, and root length for 12 weeks after planting (Table 2). The shortest average root emergence time, number of roots, and root length can be seen on Table 2.

Table 2. The effect of adding *raja* banana extract and NAA on the average root emergence time, number of roots, and root length in Borneo prima tangerine plants for 12 weeks after initiation

Treatment	Observation parameters		
	Root emergence time (days)	Number of roots	Root length (cm)
Control	5,00 ± 0,00[a]	1,00 ± 0,00[b]	2,10 ± 0,35[ab]
NAA 0.5 mg/L	4,33 ± 0,74[a]	4,67 ± 0,53[a]	1,71 ± 0,73[ab]
NAA 1.0 mg/L	6,33 ± 0,13[a]	1,00 ± 0,00[b]	0,47 ± 0,45[ab]
NAA 1.5 mg/L	5,00 ± 0,58[a]	1,33 ± 0,33[b]	0,34 ± 0,11[ab]
NAA 2.0 mg/L	7,00 ± 0,11[a]	1,00 ± 0,00[b]	0,60 ± 0,13[ab]
Raja banana extract 20 g/L	4,33 ± 0,64[a]	0,67 ± 0,17[b]	0,40 ± 0,13[ab]
Raja banana extract 50 g/L	6,00 ± 0,11[a]	1,00 ± 0,00[b]	4,50 ± 0,61[a]
Raja banana extract 75 g/L	3,33 ± 0,54[a]	1,00 ± 0,25[b]	3,57 ± 0,76[a]
Raja banana extract 100 g/L	-	-	-

Note: Numbers followed by different letters in the same column indicate a significant difference in the Mann-Whitney test at the 95% significance level

Raja banana extract and NAA have an impact on the fastest emerging root time, number of roots, and root length of Borneo prima tangerines. The best treatment to accelerate the fastest emerging root time is to use *raja* banana extract at 75 g/L, the highest number of roots was with NAA 0.5 mg/L. The longest root length was with *raja* banana extract at 50 g/L, and the treatment using *raja* banana extract at a concentration of 100 g/L produced the lowest number of roots and the shortest roots (Table 2).

Figure 4. The largest number of roots with NAA treatment at 0.5 mg/L at 12 weeks after initiation

Figure 5. The longest root length with *raja* banana extract treatment at 50 g/L at 12 weeks after initiation

DISCUSSION

Height Increase of Borneo Prima Tangerine Plants

Raja banana extract with a concentration of 75 g/L can increase plant height more than the other concentrations, which are 1.90 cm (Figure 2). This finding is in line with the research of Rahayu et al. (2021) that complex organic PGRs, including *raja* banana extract, have the potential to stimulate shoot growth by increasing plant height. The process of stem elongation occurs through a series of steps involving division, growth, and elongation of cells at the stem tip. *Raja* banana extract is one type of organic PGR that contains carbohydrates, vitamins, and phytohormones, and is a source of energy (Amaliya et al., 2022). Therefore, *raja* banana extract can act as a source of energy in the metabolic process of plants, and increase plant growth to be higher (Heriansyah, 2019).

NAA with a concentration of 1.5 mg/L shows the lowest average plant height growth, only 0.33 cm. This may be because the plants already have sufficient levels of endogenous auxin so the provision of additional exogenous auxin is not needed and can even be toxic to plants. Increasing the concentration of NAA can inhibit plant height growth (Anwar et al., 2021). Low plant growth can be caused by the non-optimization of exogenous PGR concentrations by plant needs (Samanhudi et al., 2021). The growth and development of plants is influenced by a complex relationship between endogenous and exogenous plant hormones (Lisnawati et al., 2022).

Number of Leaves of Borneo Prima Tangerines

NAA with a concentration of 0.5 mg/L on MS media showed the highest increase in the number of leaves, namely 8.67 leaves (Figure 3). Exogenous hormones with minimal concentration can encourage an increase in the number of leaves. According to the research of Mawaddah et al. (2021), the addition of auxin with a low concentration causes a response to increase the number of leaves compared to no addition or the addition of auxin with a high concentration. Various hormones, such as auxin, cytokinin, and gibberellin, can affect leaf growth and development in plants (Akhiriana et al., 2019). The main function of auxin is to stimulate root formation and promote the growth and development of meristem tissues in prospective leaves (Islamia et al., 2022).

NAA, as a synthetic auxin, can stimulate cell division in leaves, which contributes to an increase in leaf number. The number of leaves is significant in the process of photosynthesis, plant metabolism, and nutrient absorption because leaves are vital organs for plants (Indriana et al., 2020).

Photosynthesis produces carbohydrates that are essential for plant growth and development (Yuniastuti et al., 2018). The number of leaves that can grow is an important indicator in observing the potential of cells to regenerate. This potential refers to the ability of each plant cell to transform into a perfect new individual under suitable environmental conditions. Optimal growth is characterized by an increase in the number of leaves, indicating an optimal level of growth and development of the explants (Samanhudi et al., 2021).

NAA treatment with a concentration of 2.0 mg/L has the lowest average number of leaves, which is 1.67 leaves. NAA 2.0 mg/L causes changes in leaf color to brown, so it cannot carry out the photosynthesis process properly. Increasing levels of auxin hormones can stimulate ethylene production, which in turn triggers changes in leaf color to brown, wilt, and eventually fall (Samanhudi et al., 2021).

Root Emergence Time of Borneo Prima Tangerine

The treatment of *raja* banana extract with a concentration of 75 g/L on MS media was the best result for the fastest root emergence time, which was 3.33 days (Table 2). This means that the concentration of 75 g/L is the optimal concentration for root emergence time because the exogenous hormone can already encourage continuous cell division in the formation of root candidates. The balance between exogenous and endogenous auxin hormones in the optimal *raja* banana extract treatment media can form roots quickly (Andany & Ratnasari, 2023). In the initial stage of root emergence, the base of the shoot changes color to yellowish, which is then followed by swelling of the base of the shoot and the appearance of white root candidates. In siamese orange (*C. nobilis*) explants, *in vitro* shoots can produce roots because the explants can absorb nutrients from the appropriate media, which in turn stimulates rapid root formation (Ulfa & Isda, 2020).

Raja banana extract treatment with a concentration of 100 g/L did not produce roots until the end of observation (12 weeks after planting) (Table 2). This means that the concentration of 100 g/L is a concentration that is not optimal for root emergence time compared to other concentrations, because this concentration causes inhibited plant root growth caused by too high exogenous hormones. According to Utami et al. (2016), *raja* banana extract with a concentration of 150 g/L as high exogenous hormones can inhibit root formation, so only low or no exogenous hormones are needed to fulfill root formation.

Number of Roots of Borneo Prima Tangerine

NAA concentration of 0.5 mg/L in MS media produced the most optimal increase in root growth, 4.67 roots (Figure 4). This indicates that the concentration of 0.5 mg/L can stimulate root formation compared to other levels. The PGR function in root formation is auxin (Budi, 2020). Auxin given in optimal concentrations, can trigger cell division that initiates root formation (Astutik et al., 2021), has a major impact in stimulating and accelerating root growth, as well as increasing both the quantity and quality of roots (Mawaddah et al., 2021).

Root growth influences the increase of plant height. According to Gupitasari & Noli (2019), the length and quantity of roots have an impact on the growth of plant height. Roots are an essential organ for plants because they play a role in maintaining the stability and sustainability of plants (Sari et al., 2020). Its functions include as a plant intertwine into the growing medium, the main channel for delivering nutrients from the absorption site to various plant organs, an important place for metabolic activities such as respiration, storage of energy sources such as carbohydrates, and production of phytohormones such as cytokinins (Aflah et al., 2022).

Raja banana extract treatment with a concentration of 100 g/L did not produce roots (Table 2). This means that the concentration of 100 g/L is too high and blocking root growth. The application of high concentrations of exogenous PGR has an effect on the difference in the concentration of endogenous hormones in these plants. The interaction between endogenous hormones and exogenous hormones causes the physiological processes of plants to be inhibited, one of which can result in the inhibition of root formation (Mulia et al., 2020).

Root Length of Borneo Prima Tangerines

The treatment of *raja* banana extract with a concentration of 50 g/L on MS media gave the best results for the longest root length, which was 4.50 cm (Figure 5). This means that the concentration of 50 g/L is the exogenous hormone given that can spur cell elongation in the roots. *Raja* banana extract contains the hormone auxin which functions in the growth and development of vegetative organs, especially roots (Fajri et al., 2020).

Raja banana extract contains thiamine, which can accelerate root growth by accelerating cell division in the root meristem (Rahayu et al., 2021). Auxin affects cell elongation in plants, including roots, by regulating cell wall flexing. Auxin stimulates the activity of specific proteins in the plant cell membrane, which activates the pumping of H^+ ions into the cell wall, this causes the cell to elongate due to water absorption through osmosis. After elongation, the cell continues to grow by reconstructing cell wall material and cytoplasm (Setiawan & Fuskhah, 2020).

The *raja* banana extract treatment with a concentration of 100 g/L did not produce roots (Table 2). This suggests that the concentration of 100 g/L may cause inhibition of root formation because it is toxic to plants. The application of plant hormones as external PGR does not need to be done in excess because plants can produce plant hormones naturally (Desy et al., 2023). External application of low concentrations of auxin will stimulate root cell growth, but high concentrations of auxin can inhibit cell growth and root formation (Kholifah et al., 2022).

CONCLUSION

Based on the results of the study it can be concluded that the addition of *raja* banana extract into the media with a concentration of 75 g/L is the best concentration in the formation of roots in Borneo prima tangerine plants, seen from the fastest root emergence time of 3.33 days and the highest plant height increase of 1.90 cm. This research can be continued to the acclimatization stage to obtain Borneo Prima tangerine seedlings that will be widely cultivated in the field.

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