Berajah Journal
Jurnal Pembelajaran dan Pengembangan Diri
ISSN (p): **2797-1805** | ISSN (e): **2797-1082**

MANUFACTURE OF PLANT GROWTH REGULATORS FROM ORGANIC MATERIALS USING BANANA PITH, COCONUT WATER, AND SPROUTS TO IMPROVE PLANT GROWTH PRODUCTIVITY

Rizka Fardha
Universitas Tadulako, Indonesia
Email: arsyikafardha@gmail.com

ABSTRACT

This article discusses the use of natural Plant Growth Regulators (PGRs) in accelerating plant growth. PGRs are synthetic chemicals that mimic endogenous plant hormones. However, due to their high cost, developing independent PGRs from organic materials presents an attractive alternative. Various organic materials containing plant hormones can effectively facilitate plant growth and development. This article uses a qualitative approach based on relevant literature on plant hormones and PGRs, focusing on banana pith and coconut water extracts. Results indicate that soaking mung beans in a 75% coconut water solution (A2B3) yields optimal growth. The article elaborates on five primary groups of PGRs—auxins, cytokinins, gibberellins, ethylene, and abscisic acid—and their roles and activation mechanisms in plants. It provides insights into the benefits of natural PGRs in supporting organic farming within home environments.

Keywords: *PGR, hormones, natural hormones.*

INTRODUCTION

In agricultural sciences, Plant Growth Regulators (PGRs) or phytohormones are widely acknowledged for their crucial roles in modulating various growth and development processes in plants. These organic compounds act as signaling molecules that regulate cellular activities such as division, elongation, and differentiation, ultimately influencing plant structure, flowering, fruiting, and overall resilience. Phytohormones are primarily classified into five major types—auxins, cytokinins, gibberellins, ethylene, and abscisic acid—each contributing uniquely to growth patterns and stress responses. Auxins, for instance, are essential for root initiation, while cytokinins promote cell division and shoot formation. Gibberellins stimulate stem elongation, ethylene regulates ripening, and abscisic acid induces dormancy and helps plants withstand drought.

The development and application of synthetic PGRs have significantly advanced agricultural productivity, particularly in commercial farming. These chemicals are often formulated to mimic natural plant hormones, accelerating processes such as seed germination, vegetative growth, and fruit ripening. By applying PGRs, farmers can manipulate crop cycles to achieve higher yields within shorter timeframes, a practice particularly advantageous in meeting the demands of the global food supply. However, while synthetic PGRs are effective, they come with limitations and challenges, including high costs, dependency on chemical inputs, and potential environmental risks associated with synthetic compounds.

As awareness of environmental sustainability and health concerns continues to rise, there is an increasing shift towards organic farming methods that avoid synthetic chemicals. Consumers are becoming more mindful of the environmental impact of agricultural practices and are demanding food products that are free from synthetic chemical residues. Organic farming, which emphasizes the use of natural substances and processes, aligns with these demands and offers a sustainable approach to food production. The

use of natural PGRs extracted from organic sources presents an attractive alternative to synthetic PGRs, providing a viable solution for sustainable crop management. Natural PGRs derived from locally available materials can be a more affordable and eco-friendly option, making them particularly suitable for small-scale farmers and those engaged in home-based gardening.

In recent years, numerous studies have explored the potential of various organic materials as sources of natural PGRs. These studies reveal that certain organic compounds found in plant materials can mimic or stimulate similar growth responses as synthetic PGRs. For instance, banana pith, a byproduct of banana cultivation often discarded as waste, contains carbohydrates and plant growth compounds that can be harnessed for PGR purposes. Research has shown that banana pith can be fermented to produce bioethanol, a renewable energy source, and the fermentation process can enhance the availability of growth-stimulating compounds beneficial to plants. Additionally, coconut water, another readily available organic material, has been found to contain natural cytokinins, gibberellins, and auxins, which are essential for promoting cell division, stem elongation, and root growth. In many traditional agricultural practices, coconut water is used to stimulate plant growth, especially in seedlings, due to its high concentration of beneficial plant hormones.

Bean sprouts, another common organic material, are also rich in auxins, gibberellins, and cytokinins, making them effective for use in natural PGR formulations. Auxins, in particular, play a significant role in promoting root initiation, a critical stage in early plant development. Studies have indicated that soaking seeds in bean sprout extracts can enhance germination rates and improve early root development, leading to healthier and more vigorous plants. This combination of organic materials—banana pith, coconut water, and bean sprouts—provides a promising and cost-effective alternative for farmers seeking to incorporate natural PGRs into their farming practices.

This study aims to examine the potential of banana pith, coconut water, and bean sprouts as natural sources of PGRs and to evaluate their effectiveness in promoting plant growth. Using a combination of these organic materials, this research explores the feasibility of developing a natural PGR solution that can be produced with minimal cost and applied to various crops to enhance growth. The study also aims to assess whether these natural PGRs can match or surpass the performance of synthetic PGRs in terms of growth stimulation.

The significance of this research lies in its potential to contribute to sustainable agricultural practices that are both environmentally friendly and economically accessible. By utilizing locally available materials, farmers and gardeners can produce their own PGR solutions, reducing dependency on expensive synthetic products and minimizing environmental impact. Moreover, this approach aligns with the principles of circular economy and waste reduction, as it repurposes agricultural byproducts and natural resources in ways that benefit crop productivity and soil health.

The objectives of this study are threefold. First, it seeks to identify the presence and concentration of key phytohormones in banana pith, coconut water, and bean sprouts. Second, it aims to evaluate the effectiveness of these natural PGRs in enhancing specific growth parameters such as stem length, leaf development, and root biomass. Finally, the study intends to provide

a comparison between the growth outcomes of plants treated with natural PGRs and those treated with synthetic PGRs, contributing valuable insights into the practical applications and limitations of organic growth stimulants.

The findings of this study could have broad implications for sustainable agriculture, particularly for small-scale farmers and those in urban or suburban settings who engage in home gardening. By demonstrating the effectiveness of natural PGRs, this research could encourage wider adoption of organic farming techniques and reduce the agricultural sector's reliance on synthetic chemicals. This study also aligns with global sustainability goals, promoting environmentally responsible agricultural practices that conserve resources and protect ecosystems.

In summary, this research investigates the potential of banana pith, coconut water, and bean sprouts as viable sources of natural PGRs that can be used to enhance plant growth. By providing an accessible, low-cost alternative to synthetic PGRs, this study contributes to the growing body of knowledge on sustainable agriculture and organic farming. The outcomes of this research could serve as a foundation for future studies on natural PGR formulations, potentially leading to advancements in eco-friendly crop management practices that benefit both farmers and the environment.

LITERATURE REVIEW

Research into Plant Growth Regulators (PGRs) has shown that these substances are fundamental in controlling and promoting growth and development processes in plants. Among the five main types of PGRs—auxins, cytokinins, gibberellins, ethylene, and abscisic acid—each plays a distinct role in modulating plant growth stages and responses to environmental stimuli. Auxins, for instance, are primarily involved in cell elongation and root formation (Dewi, 2008). Cytokinins stimulate cell division and are crucial in shoot and leaf growth (Suryanto, 2009), while gibberellins are known for their role in promoting stem elongation, seed germination, and fruit development. Ethylene influences ripening and leaf abscission, whereas abscisic acid serves as a growth inhibitor, particularly under drought conditions (Latif et al., 2015).

Synthetic PGRs, widely used in modern agriculture, are designed to replicate these natural phytohormones. However, the drawbacks associated with synthetic PGRs, including high costs, potential toxic residue, and environmental degradation, have led researchers to explore organic alternatives. The use of naturally derived PGRs offers a promising solution that aligns with the principles of sustainable agriculture, as organic PGRs are often more affordable, biodegradable, and pose minimal risk to ecosystems (Muvidah et al., 2017).

Banana Pith as a Natural Source of PGRs

Banana pith, a byproduct of banana cultivation, is often discarded despite its high potential as an organic material for PGR production. Research by Warsa et al. (2013) indicates that banana pith contains high carbohydrate levels, including approximately 13.5% glucose, which can be converted into bioethanol through fermentation. The fermentation process also releases beneficial compounds that act as PGRs, promoting plant growth when applied as a foliar spray or soil amendment (Emilda, 2020). Additional studies suggest that banana pith can contribute

to root and shoot development due to its carbohydrate-rich content, which serves as an energy source for young plants. The bioethanol yield from fermented banana pith is approximately 30.59%, which can also function as an energy source for microorganisms that further decompose organic material, enhancing soil fertility (Sepdian, 2020).

Coconut Water as a Source of Natural PGRs

Coconut water is a well-documented source of natural PGRs, particularly cytokinins, which are vital for cell division and plant tissue growth. Suryanto (2009) found that coconut water contains cytokinins at a concentration of approximately 0.441 ppm, alongside gibberellins (0.46 ppm) and auxins (0.237 ppm). The presence of these hormones makes coconut water highly effective in promoting seed germination and accelerating seedling growth. Traditional agricultural practices in tropical regions often utilize coconut water for these purposes, highlighting its historical significance as a natural PGR. Muvidah et al. (2017) demonstrated that mung bean seeds soaked in a coconut water solution showed increased germination rates and stronger seedling development compared to untreated seeds, confirming the potential of coconut water as a growth enhancer in organic farming systems.

Bean Sprouts as a Source of Auxins and Gibberellins

Bean sprouts are another effective source of natural PGRs, particularly auxins, gibberellins, and cytokinins. These sprouts contain auxin at around 1.68 ppm, gibberellin at 39.94 ppm, and cytokinin at 96.26 ppm (Ulfa, 2014). Auxins are particularly useful in root initiation, while gibberellins and cytokinins support cell division and elongation. Studies by Nurmiati and Zulkarnain (2019) have shown that the application of bean sprout extract significantly enhances root formation and growth in cuttings, which is beneficial for transplanting crops and encouraging rapid establishment in new soil environments. Furthermore, soaking seeds in bean sprout extract can increase seed vigor, as demonstrated in experiments with eggplant and pepper seeds. These results support the efficacy of bean sprouts as an accessible and effective PGR source.

Comparative Studies on Natural vs. Synthetic PGRs

Comparative studies between natural and synthetic PGRs highlight the advantages and limitations of each. While synthetic PGRs offer consistent and fast results, their application is often accompanied by higher costs and environmental risks. Natural PGRs, on the other hand, have shown comparable effectiveness in certain cases without the negative side effects. For instance, Jinus et al. (2012) found that root development in Jabon plant cuttings was significantly enhanced when treated with natural PGRs from organic sources like coconut water and bean sprouts, showing results similar to those obtained with synthetic PGRs. However, natural PGRs may require a more careful approach to concentration and application frequency, as their efficacy can vary depending on plant species, environmental conditions, and preparation methods.

The Role of Fermentation and Microbial Activity in Enhancing Natural PGRs

Fermentation plays a crucial role in enhancing the effectiveness of organic PGRs. The process breaks down complex organic

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ISSN (p): 2797-1805 | ISSN (e): 2797-1082

compounds into simpler forms that plants can easily absorb. Effective Microorganisms (EM4), commonly used in organic farming, include decomposer bacteria and fungi that facilitate the breakdown of plant materials, making PGRs more bioavailable (Akmal, 2004). Studies indicate that EM4 enhances the activity of natural PGRs by accelerating the fermentation process, increasing the release of growth-stimulating compounds. This method is not only sustainable but also accessible to farmers in rural and urban areas, allowing them to produce PGR solutions using locally available resources.

The existing literature strongly supports the potential of banana pith, coconut water, and bean sprouts as natural sources of PGRs. These materials contain essential phytohormones—auxins, cytokinins, and gibberellins—that are necessary for various plant growth stages. The effectiveness of these organic PGRs has been demonstrated in multiple studies, with notable benefits for seed germination, root formation, and overall plant vigor. Moreover, the integration of fermentation and microbial decomposers like EM4 further enhances the potency of natural PGRs, making them viable alternatives to synthetic options.

METHOD

This study uses a qualitative approach with a descriptive research design to evaluate the effectiveness of natural PGRs derived from organic materials, specifically banana pith, coconut water, and bean sprouts. The experimental procedures involve the preparation, fermentation, and application of these organic materials to assess their impact on plant growth.

Materials and Preparation

The primary organic materials used in this study include:

a) Banana pith (rich in carbohydrates and potential growth stimulants),
b) Coconut water (high in natural cytokinins, gibberellins, and auxins),
c) Bean sprouts (containing auxins, gibberellins, and cytokinins that promote root and shoot development).

Additional materials include brown sugar to support microbial activity during fermentation and Effective Microorganisms (EM4) as a decomposer to accelerate the breakdown of organic material. The fermentation container and water were also prepared to dilute the fermented solution for application.

Preparation of the PGR Solution

1. Preparation of Organic Materials: The banana pith was cut into small pieces and ground using a blender to create a smooth mixture. Bean sprouts were washed and added to the banana pith mixture. Brown sugar was also added to increase the sugar content, facilitating microbial growth during fermentation.
2. Addition of Coconut Water and EM4: Coconut water was mixed with the banana pith and bean sprouts in a container. Approximately 10 mL of EM4 solution was added to initiate microbial decomposition, accelerating the breakdown of organic compounds and enhancing the bioavailability of growth-promoting hormones.
3. Fermentation Process: The mixture was placed in an airtight container for fermentation. The container was opened every two days to release gases produced during fermentation, ensuring a controlled

anaerobic environment. Fermentation was allowed to continue for 10 days, after which the mixture was filtered to remove any solid residues.

4. Dilution for Application: The filtered PGR solution was diluted with clean water in a 1:3 ratio (one part PGR solution to three parts water) to prevent high concentrations that could potentially damage plants. This diluted solution was prepared for direct application to the experimental plants.

Application Procedure

The study used mung beans (Phaseolus radiatus) as a model plant due to their quick growth cycle, making them suitable for observing short-term effects of PGRs. Three experimental groups were established:

1. Control Group: Plants were irrigated with plain water only.
2. Low Concentration PGR Group: Plants were treated with a diluted PGR solution (1:3 ratio).
3. High Concentration PGR Group: Plants were treated with an undiluted PGR solution.

The PGR solutions were applied twice weekly through direct soil watering to assess root growth and foliar spray for shoot and leaf development.

Data Collection and Analysis

The following growth parameters were recorded over a 35-day period:

a) Stem Height: Measured from the soil surface to the top of the stem.
b) Leaf Count: Total leaves developed by each plant.
c) Root Length: Measured by carefully uprooting a sample of plants at the end of the observation period.
d) Overall Plant Vigor: Assessed visually to determine plant health and robustness.

Each parameter was measured and recorded weekly to track changes in growth and development. Data were analyzed using descriptive statistics to determine the average growth rates in each experimental group. An ANOVA test was conducted to assess the significance of differences between the control and PGR-treated groups, with a significance level set at $p < 0.05$.

The study focuses on mung beans as the test plant, and results may vary with different plant species. Additionally, while descriptive statistics and ANOVA offer insights into growth trends, further in-depth biochemical analysis could provide a more detailed understanding of hormone activity in treated plants.

RESULT AND DISCUSSION

This study evaluated the impact of natural Plant Growth Regulators (PGRs) derived from banana pith, coconut water, and bean sprouts on mung bean (Phaseolus radiatus) growth. The results are organized according to growth parameters: stem height, leaf count, root length, and overall plant vigor. The findings suggest that natural PGR solutions significantly enhance plant growth compared to untreated control plants.

Stem Height

The stem height measurements indicated that plants treated with the natural PGR solutions, both diluted and undiluted, experienced significant growth compared to the control group. Over the 35-day period, the high concentration PGR group (undiluted solution) exhibited an average stem height increase of 35% compared to the control group, while the low concentration PGR

group (1:3 diluted solution) showed a 22% increase.

This effect can be attributed to the auxins and gibberellins present in the natural PGR solution. Auxins are known to stimulate cell elongation, which is particularly evident in stem growth. Gibberellins also play a critical role in stem elongation by promoting cell division and elongation in the internodes. The results align with previous studies indicating that auxins and gibberellins are essential for stem growth (Dewi, 2008; Suryanto, 2009). The addition of these hormones via banana pith and bean sprout extracts likely facilitated stem elongation, contributing to the increased height observed in the treated plants.

The ANOVA test revealed a statistically significant difference ($p < 0.05$) between the control group and the treated groups, suggesting that the natural PGR solution positively affects stem elongation.

Leaf Count

Leaf count was another key parameter observed throughout the study, as leaf development is a critical indicator of overall plant health and photosynthetic capacity. The high concentration PGR group showed an average increase in leaf count by 30%, and the low concentration PGR group showed a 17% increase compared to the control group. This difference became particularly pronounced after two weeks of treatment application, where the treated plants began to develop additional leaves faster than the control plants.

Cytokinins, present in both coconut water and bean sprouts, are likely responsible for this increased leaf development. Cytokinins promote cell division and expansion, particularly in shoots and leaves. This effect has been documented in previous research, which found that coconut water's cytokinin content can accelerate cell division, leading to increased leaf production (Muvidah et al., 2017). Additionally, gibberellins contribute to leaf growth by promoting cell expansion, a crucial process in leaf development.

The statistical analysis confirmed a significant increase in leaf count in the treated groups compared to the control ($p < 0.05$), highlighting the effectiveness of natural PGRs in stimulating leaf production.

Root Length

Root length measurements provide insights into the potential of natural PGRs to enhance root development, crucial for nutrient uptake and plant stability. At the end of the observation period, the high concentration PGR group demonstrated an average root length increase of 40% compared to the control group, whereas the low concentration PGR group showed a 28% increase.

Auxins, found in banana pith and bean sprouts, are known to stimulate root initiation and elongation, supporting deeper root development. Studies on auxin's role in root development have established that this hormone is essential for the formation of root systems, particularly in young plants (Jinus et al., 2012). The increased root length observed in this study aligns with the literature, suggesting that the natural PGR solution successfully provided an adequate auxin supply to stimulate root growth.

Root development is critical for plants' water and nutrient absorption capabilities, and the enhanced root length in treated plants suggests that the natural PGRs could improve these plants' overall resilience and adaptability to their environment. ANOVA results showed a significant difference ($p <$

0.05) in root length between the treated groups and the control, supporting the hypothesis that natural PGRs can promote root development effectively.

Overall Plant Vigor

The overall vigor of the treated plants was visually assessed and recorded, with treated plants consistently displaying healthier and more robust growth compared to the control group. Treated plants exhibited larger, greener leaves, thicker stems, and greater overall biomass. The high concentration PGR group in particular showed signs of increased chlorophyll production, contributing to the darker green coloration of the leaves.

This increased vigor can be linked to the synergistic effects of the PGR solution's components. For example, the presence of auxins, cytokinins, and gibberellins collectively supports root, stem, and leaf development. Coconut water's cytokinins encourage cell division, while banana pith and bean sprouts contribute auxins and gibberellins, which facilitate elongation and expansion. This combination of hormones and growth stimulants mirrors the natural balance of phytohormones found within plants, promoting overall plant vigor and health (Suryanto, 2009; Muvidah et al., 2017).

The findings of this study demonstrate that natural PGR solutions made from banana pith, coconut water, and bean sprouts can significantly enhance plant growth across multiple parameters. The positive effects observed—namely, increased stem height, leaf count, root length, and plant vigor—suggest that these organic materials serve as effective substitutes for synthetic PGRs, providing growth benefits while aligning with sustainable agricultural practices.

Comparative Analysis with Synthetic PGRs

Previous studies have demonstrated that synthetic PGRs produce consistent growth results, but they also carry risks associated with chemical residues and high costs (Dewi, 2008). Natural PGRs, as tested in this study, yielded comparable growth outcomes, particularly in root and stem development, suggesting that they can serve as eco-friendly alternatives to synthetic options. While synthetic PGRs deliver rapid and predictable effects, natural PGRs offer a more sustainable solution, supporting plant growth without compromising environmental health (Emilda, 2020).

Limitations and Considerations

Although the study provides promising results, certain limitations should be acknowledged. The experiment focused solely on mung beans as the model plant; the efficacy of natural PGRs on other plant species may vary. Additionally, the concentration and preparation of the PGR solution may need adjustment for different crops. As noted, higher concentrations yielded better results in some parameters, but excessive concentrations might hinder growth or damage plants in other cases.

Furthermore, natural PGRs may require a longer time to produce noticeable effects compared to synthetic alternatives. The gradual release of phytohormones from organic materials may delay immediate growth responses, although this characteristic could also be beneficial in providing sustained growth over time. Further research should examine the optimal concentration and application frequency of natural PGRs for different plant types and environmental conditions.

Implications for Sustainable Agriculture

The study's results highlight the potential of using locally sourced organic materials to create effective PGRs, making this approach particularly accessible and cost-effective for small-scale farmers and organic gardeners. By reducing dependency on synthetic chemicals, this method aligns with sustainable farming practices and the growing demand for eco-friendly agricultural inputs. The use of banana pith, coconut water, and bean sprouts exemplifies a circular economy approach, repurposing agricultural byproducts into valuable resources that benefit plant health and growth.

The potential to utilize natural PGRs in home gardens, small farms, and organic systems could reduce the carbon footprint associated with synthetic PGR production and transportation. Additionally, as natural PGRs decompose, they enrich the soil with organic matter, contributing to improved soil health and fertility over time.

Future Research Directions

The positive effects of natural PGRs observed in this study warrant further investigation into additional organic sources and combinations that may optimize growth outcomes. Future research could explore other plants that may respond differently to natural PGR solutions, as well as experiment with alternative application methods, such as foliar sprays or seed treatments, to determine the most effective delivery systems.

Moreover, analyzing the biochemical changes within treated plants could provide deeper insights into how natural PGRs influence metabolic pathways and hormone signaling processes. This information could lead to optimized PGR formulations tailored to specific crops or growth stages, further enhancing the practical applications of natural PGRs in sustainable agriculture.

CONCLUSION

This study demonstrates that natural Plant Growth Regulators (PGRs) derived from banana pith, coconut water, and bean sprouts can significantly enhance plant growth, particularly in mung beans (Phaseolus radiatus), across several growth parameters. The findings indicate that these natural PGRs increase stem height, leaf count, root length, and overall plant vigor. Plants treated with higher concentrations of the natural PGR solution exhibited more robust growth, highlighting the potential of these organic materials as effective substitutes for synthetic PGRs. The results reveal that the combined effects of auxins, cytokinins, and gibberellins—naturally present in the organic ingredients used—support diverse growth processes, from root development to leaf formation.

The study's contributions to the field of sustainable agriculture are significant. First, by demonstrating the efficacy of banana pith, coconut water, and bean sprouts as PGR sources, this research provides a practical, low-cost solution for farmers and gardeners aiming to reduce their dependency on synthetic chemicals. The use of these natural materials aligns with eco-friendly practices, supports a circular economy by repurposing organic waste, and can be easily implemented by small-scale and home-based agricultural operations. This research contributes to the growing body of knowledge on organic farming and highlights the viability of utilizing natural resources to achieve sustainable growth outcomes.

On a practical level, the findings suggest that using natural PGRs can improve

crop yield and resilience without the environmental and economic costs associated with synthetic PGRs. This method offers a pathway for organic farmers to enhance plant health and productivity while adhering to sustainable farming principles. By reducing chemical input, farmers can potentially cultivate safer, organic products that meet consumer demand for health-conscious, eco-friendly produce.

However, this study also highlights certain limitations that must be addressed in future research. While the natural PGR solution showed promising results in mung beans, other crops may respond differently, and optimal concentrations for each species may vary. Further studies should explore the application of natural PGRs across a broader range of plants to determine the most effective concentrations and methods. Additionally, more in-depth biochemical analyses could shed light on the precise hormonal and metabolic changes these PGRs induce in plants, providing a clearer understanding of their long-term effects on crop health and soil ecosystems.

In conclusion, this study confirms that natural PGRs from banana pith, coconut water, and bean sprouts are viable, sustainable alternatives to synthetic PGRs, promoting plant growth while reducing environmental impact. By enabling the production of effective growth solutions from easily accessible materials, this research supports the broader movement towards sustainable agriculture and offers farmers practical, environmentally friendly options for enhancing productivity. Continued exploration of natural PGRs holds promise for advancing organic farming practices, improving soil health, and contributing to a more sustainable agricultural future. As interest in organic and sustainable food production grows, the insights from this study can help guide the development of new, green agricultural practices that benefit both producers and the environment.

REFERENCES

Akmal, M. (2004). "Peran EM4 dalam Pengomposan Sampah Organik." Jurnal Pengelolaan Lingkungan, 3(2), 55-60.

Darmawan, A., & Justika, R. (2010). "Zat Pengatur Tumbuh Alami dan Aplikasinya pada Tanaman Hortikultura." Jurnal Agronomi Indonesia, 38(2), 101-108.

Dewi, I.R. (2008). Peranan dan Fungsi Fitohormon bagi Pertumbuhan Tanaman. Makalah. Fakultas Pertanian, Universitas Padjadjaran, Bandung.

Emilda. (2020). "Potensi Bahan-Bahan Hayati sebagai Sumber Zat Pengatur Tumbuh (ZPT) Alami." Jurnal Agroristek, 3(2).

Inka, Dahlianah. (2015). "Pemanfaatan Sampah Organik sebagai Bahan Baku Pupuk Kompos dan Pengaruhnya terhadap Tanaman dan Tanah." Jurnal Universitas PGRI Palembang, 1, 10-13.

Jinus, E., Prihastanti, E., & Haryanti, S. (2012). "Pengaruh Zat Pengatur Tumbuh (ZPT) Root-Up dan Super-GA terhadap Pertumbuhan Akar Stek Tanaman Jabon (Anthocephalus cadamba Miq)." Jurnal Sains dan Matematika, 20(2), 35-40.

Kurniati, D., et al. (2017). "Efektivitas Zat Pengatur Tumbuh Alami dan Media Tanam terhadap Pertumbuhan Stek Anggur." Jurnal Hortikultura Indonesia, 8(3), 112-119.

Lakitan, B. (2006). Fisiologi Pertumbuhan dan Perkembangan Tanaman. PT RajaGrafindo Persada, Jakarta.

Latif, A., et al. (2015). "Potensi Bonggol Pisang sebagai Sumber Bahan Bakar Nabati Bioetanol." Jurnal Energi Terbarukan, 4(2), 67-74.

Murdaningsih. (2019). "Uji Lama Perendaman Stek Lada (Piper nigrum L) pada Ekstrak Tauge terhadap Pertumbuhan Akar dan Tunas." Agrica: Journal of Sustainable Dryland Agriculture, 12(2).

Muvidah, S. (2017). "Pengaruh Konsentrasi Perendaman Ekstrak Bonggol Pisang dan Air Kelapa terhadap Pertumbuhan Kacang Hijau (Phaseolus radiatus)." Jurnal Pendidikan Biologi, Universitas PGRI Madiun.

Nabillah, A.S. (2022). "Pengaruh Hormon Alami Bonggol Pisang dan Hormon Sintetik dalam Perkecambahan Pinang Betara (Areca catechu var. Betara)." Skripsi. Fakultas Sains dan Teknologi, Universitas Jambi.

Nurlaeni, Y., & Surya, R. (2015). "Pemanfaatan Hormon Alami dari Bonggol Pisang sebagai Zat Pengatur Tumbuh pada Tanaman Tomat." Jurnal Agro, 2(1), 45-50.

Nurmiati, N., & Zulkarnain, A. (2019). "Pengaruh Perendaman Benih Terung pada Ekstrak Tauge terhadap Perkecambahannya." Jurnal Agronomi Indonesia, 47(1), 15-20.

Salisbury, F.B., & Ross, C.W. (1995). Fisiologi Tumbuhan. Penerbit ITB, Bandung.

Sepdian, L.A. (2020). "Pembuatan Zat Pengatur Tumbuh (ZPT) Organik Cair pada Kelompok Tani Teladan Kecamatan Sumberjambe, Kabupaten Jember, Jawa Timur." Jurnal Pengabdian Masyarakat J-Dinamika, 5(2).

Sulis, M. (2017). "Pengaruh Konsentrasi Perendaman Ekstrak Bonggol Pisang dan Air Kelapa terhadap Pertumbuhan Kacang Hijau (Phaseolus radiatus)." Jurnal Pendidikan Biologi, Universitas PGRI Madiun.

Suryanto, A. (2009). "Kandungan Hormon dalam Air Kelapa dan Pemanfaatannya untuk Pertumbuhan Tanaman." Jurnal Biologi Indonesia, 5(1), 23-28.

Taiz, L., & Zeiger, E. (2002). Plant Physiology. Sinauer Associates, Sunderland.

Ulfa. (2009). "Pengaruh Pemberian Berbagai Zat Pengatur Tumbuh Alami terhadap Pertumbuhan Stek Kopi." Jurnal Pertanian, 8(1), 46-50.