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# Effectiveness of Natural PGR Made from Shallot Filtrate and *Aloe vera* on the Growth of Cayenne Pepper (*Capsicum frutescens* L.)

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**Abstract**
Cayenne pepper (*Capsicum frutescens* L.) is popular cooking fruit because the majority likes spicy flavor. Sometimes, there is a surge in prices because a decrease in production that occurs due to several factors, one of which is during the planting and cultivation process. Farmers overcome these problems using natural Plant Growth Regulators (PGR) from shallot filtrate and *Aloe vera* as growth support. The auxin and gibberellin hormones contained in these materials can be used to support the growth of cayenne pepper. This study aims to determine the effect of natural PGR administration and the most optimal concentration of natural PGR from these materials on the growth of cayenne pepper. This study used Randomized Block Design one factorial, namely the concentration of natural PGR with 5 concentrations control, 60%, 70%, 80%, and 90% with five repetitions. The parameters measured were plant height, number of leaves, and stem diameter. Data analysis used One-Way ANOVA test, followed by Duncan's test if significant. The results showed there was an effect of natural PGR, and 90% were the concentrations that provided the best growth with the highest average value of plants 12 cm, the largest number of leaves 10.8 strands, and the largest stem diameter value 1.76 mm.

**Keywords:** *Aloe vera*; agricultural innovation; growth; Plant Growth Regulators; shallots.

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## INTRODUCTION

Chili pepper (with the scientific name *Capsicum* sp.) is a type of shrub that comes from the nightshade family Solanaceae and originates from Peru on the American continent. The type of pepper that Indonesians most prefer is the cayenne pepper, which is scientifically named *Capsicum frutescens* L. This is because most Indonesians like spicy food; thus, one of the most important cooking ingredients and always used by most Indonesians in their daily lives is cayenne pepper. Therefore, cayenne pepper is widely cultivated by farmers in Indonesia because many people often consume and use it as a cooking ingredient.

Information from Statistics Indonesia (BPS) in 2020 has recorded that the number of cayenne pepper production in Indonesia in 2020 reached 1.51 million tons, which increased by 9.76% compared to the production of 1.37 million tons in the previous year (Dihni, 2021). The increase and decrease of cayenne pepper production every year causes a lack or inconsistency of cayenne pepper availability, while the consumption rate of cayenne pepper by Indonesians continues to increase every year. This causes the price of cayenne pepper to rise in the market. Factors such as season for producing cayenne pepper, rain, production cost, and length of distribution can affect the price of cayenne pepper (The Ministry of Trade, 2016). One of the methods to minimize the increase in the selling price of cayenne pepper is to ensure a sufficient amount of cayenne pepper on the market by planting them every season, including during the rainy season (The Ministry of Trade, 2019).

In the process of planting and cultivating cayenne pepper, farmers in Indonesia not only require good organic fertilizer but also other elements, such as Plant Growth Regulators (PGR). Plant Growth Regulators (PGR) are organic compounds that can be active in low concentrations and can stimulate, inhibit, or change plant growth and development (Rajiman, 2018). In another definition, Plant Growth

Regulators (PGR) are non-nutrient organic compounds that ion in low concentrations to accelerate or inhibit the plant growth and development process (Jadid *et al*., 2024).

The application of PGR is generally found in natural PGR and synthetic PGR (Lestari *et al*., 2022). Generally, farmers use synthetic PGR in the form of Gibgro 10 SP, which contains gibberellic acid (GA3) that has the function of increasing morphological and physiological effects of plants in low doses, but if it is used too often in large quantities, it can increase the expenses. Thus, according to Berlintina *et al*. (2020), if PGR is produced from organic materials, it will be cheaper, more accessible, safer to use, and environmentally friendly. Some natural ingredients that can be used as natural PGR are shallot filtrate and *Aloe vera* filtrate.

The use of shallot extract is more profitable because it makes farmers easier to obtain practical PGR from environmentally friendly natural resources (Handayani *et al*., 2023). Shallot contains growth hormones, such as auxin and gibberellin, which are able to accelerate seed development (Marfirani *et al*., 2014). Auxin will stimulate specific proteins in the cell plasma membrane that will pump H+ ions into the cell wall, where the H+ ions function in activating enzymes and breaking the hydrogen bonds in cell walls, resulting in water entering through the osmosis process and causing cell growth (Alpriyan and Karyawati, 2018). The results of the study by Simanjuntak *et al*. (2021) stated that a concentration of shallot extract of 200 g/l of water can increase the plant height by 9.37 cm, while agarwood seeds with a concentration of 100 g/l of water can increase the number of leaves by 10.3 leaves.

*Aloe vera* contains a content that can be used to affect growth. This is possible because *Aloe vera* sap contains minerals, vitamins, amino acids, and auxin hormones, which are Plant Growth Regulators (PGR). Besides having nutritional content, *Aloe vera* contains a gel consisting of 96% water and 4% solid and contains 75 compound contents that have benefits (Nasution *et al*., 2023).

The combination of natural PGR made from shallots and the addition of *Aloe vera* has been carried out previously in the study by Afifuddin *et al*. (2022), where it can be found that adding shallot extract and 70% of *Aloe vera* can influence achieve optimal level of root development of hibiscus stem cuttings in all parameters. This is due to the many nutrients contained in *Aloe vera*, including enzymes, minerals, sugars, fatty acids, and hormones, such as auxin and gibberellin hormones (Primasari, 2019).

Salisbury and Ross (1995a) stated that the ability of gibberellin to accelerate cell elongation at the shoot tip and cell growth is caused by the ability of gibberellin hormone to increase the hydrolysis level of starch and sucrose into glucose and fructose, so it can affect the increase in cell wall plasticity. Increased elongation of young stems (still growing) is one of the effects of the most obvious effects of GA and occurs without changes in the number of nodes, and internode growth is accelerated by the increase of cell elongation, which is then proven to be caused by cell wall relaxation rather than cell expansion (Hedden and Sponsel, 2015). Meanwhile, nutrient contents, such as sugar or sucrose, have many functions to help cell growth, such as producing energy during respiration, controlling membrane stabilization, controlling osmotic pressure, and helping new cell growth in the plant (Heriansyah, 2019). The objective of this research was to study the effect of applying natural PGR made from shallot filtrate and the addition of *Aloe vera* filtrate on the development of cayenne pepper plants and the most optimal concentration that can be given for the growth of cayenne pepper.

## MATERIALS AND METHODS

This research was experimental through a 1-factorial Randomized Block Design (RBD) in the form of the concentrations of natural PGR (control, 60%, 70%, 80%, and 90%). This research was conducted from December 2023 to March 2024 in Perumahan Dolog Wadungasih Buduran Sidoarjo. In this research, several tools were used: plastic raffia string, measuring tape, pot tray, 15x15 cm polybag, wood, plastic cup, hand sprayer, measuring cup, label, camera, scissor, stationery, basin, hoe, ruler, caliper, and blender. Moreover, the materials used were Bhaskara cayenne pepper seeds, solid, manure, cocopeat, water, and natural plant growth regulators produced from the shallot and *Aloe vera* filtrates.

Steps in this research included seeding cayenne pepper seeds in a pot tray with a ratio of soil, manure, and cocopeat of 1:1:1, which is then covered with some soils. Seeding was carried out for 14 days or until the cayenne pepper plant had 2-4 leaves. The next step was preparing a labeled polybag as a growing medium after transplanting with a ratio of soil, manure, and cocopeat of 2:1:1. Transplanting into polybag was carried out when cayenne pepper plants have 2-4 leaves and in the morning to prevent excessive sunlight.

Moreover, the process of making filtrate began with the preparation of shallots and *Aloe vera*, each of which requires approximately 1 kg. This refers to the study by Diana (2014), which used 1 kg of shallots to make filtrate. The next step was to use a blender to crush the shallots; after the shallots were

blended, the resulting liquid was then filtered from the dregs using a filter cloth, and the resulting liquid was a solution preparation considered 100% natural. *Aloe vera* also used the same method to produce filtrate, and after both ingredients were produced, both were homogenized and then diluted. Dilution was carried out using distilled water before being applied to cayenne pepper with a formula referring to the study by Sofwan *et al*. (2018) :

$$V1 \; x \; M1 = V2 \; x \; M2$$

Notes:
V1 : volume of stock solution
M1 : concentration of stock solution
V2 : volume of treatment solution
M2 : desired solution concentration

The application of natural PGR made from shallot filtrate and the addition of *Aloe vera* filtrate was carried out once a week with a spraying volume of 50 ml per plant. Plant maintenance was carried out by cleaning weeds and watering once every 2 days in the morning.

The growth parameters of the cayenne pepper plant were observed by measuring the plant height using a ruler (cm), calculating the number of leaves by observing leaves that had opened perfectly, and measuring stem diameter using a caliper (mm) once a week from 14 Days After Planting (DAP) to 35 Days After Planting (DAP). Plant height analyzed using a One-Way ANOVA test, followed by Duncan's test and number of leaves and stem diameter only using a One-Way ANOVA test.

## RESULTS

Based on the results of the research regarding the effect of using natural PGR made from shallot filtrate and the addition of *Aloe vera* filtrate on the growth of cayenne pepper, it was found the parameters of plant height, number of leaves, and stem diameter. The data of the research results were then analyzed using the One Way ANOVA test, and followed by Duncan's test if the result is significant, as seen in Table 1.

**Table 1.** Average plant height, number of leaves, and stem diameter at various plant ages due to the use of natural plant growth regulators made from shallot and *Aloe vera* filtrates on the growth of cayenne pepper (*Capsicum frutescens* L.)

| Natural PGR Treatment (ml) | Plant Height * (cm) 35 DAP ± SD | Number of Leaves (leaves) 35 DAP ± SD | Stem Diameter (mm) 35 DAP ± SD |
|---|---|---|---|
| K0(Control) | 8.5 ± 1.06[a] | 8.4 ± 1.52 | 1.42 ± 0.16 |
| K1 ( 60%) | 8.6 ± 1.64[a] | 8.8 ± 1.30 | 1.5 ± 0.25 |
| K2 (70%) | 9.9 ± 0.82[a] | 9.6 ± 0.89 | 1.68 ± 0.19 |
| K3 (80%) | 10.2 ± 2.28[ab] | 9.6 ± 2.41 | 1.64 ± 0.18 |
| K4 (90%) | 12 ± 0.87[b] | 10.8 ± 0.84 | 1.76 ± 0.23 |

Note: *Values followed by different letters in the same row are significantly different according to Duncan's test at 5% level.

Based on the results of data analysis, it was found that the treatment of administering natural PGR made from shallot filtrate and *Aloe vera* filtrate had a significant effect on the parameter of plant height, so Duncan's test was followed. Based on the data obtained, the highest average was a plant administered by natural PGR made from 90% shallot filtrate + 90% *Aloe vera* filtrate with a value of 12 cm. Meanwhile, the lowest average was for plants that did not administer natural PGR or control, with a value of 8.5 cm.

The effect of administering natural PGR on the parameter of the number of leaves and stem diameter was found to not have a significant effect, so Duncan's test was not followed. Based on the data obtained, the highest average number of leaves and the largest stem diameter were plants administered by natural PGR made from 90% shallot filtrate + 90% *Aloe vera* filtrate with a number of leaves of 10.8 leaves and a stem diameter of 1.76 mm. Meanwhile, the lowest average was a plant that did not administer natural PGR or control, with an average number of leaves of 8.4 leaves and a stem diameter of 1.42 mm.

## DISCUSSION

The results of the analysis showed that interaction was found between the administration of natural PGR made from shallot filtrate and *Aloe vera* filtrate watered on cayenne pepper plant, which shows that there was an effect of administering natural PGR made from shallot filtrate and *Aloe vera*

filtrate watered on cayenne pepper plant. A concentration of natural ZPT of 90% shallot filtrate + 90% *Aloe vera* filtrate was a concentration that provides the best growth effect and can be used to support cayenne pepper growth because it contains a higher auxin and gibberellin than found in other concentrations. Shallot extract is rich in auxin (IAA) of 10.355 ppm per 100 ml (Kurniati *et al*., 2017). Moreover, shallot filtrate contains gibberellin, which increases the activity of hydrolysis enzymes, especially α-amylase, to break down starch into glucose. This is in line with Lakitan (1996), which stated that glucose is important for cell respiration and provides energy for growth, increasing the concentrations of fructan, sugars, and starches by gibberellin and accelerating cell division by producing fructose and glucose through hydrolysis of these substances.

Irvan and Adriana (2017) explained that plant stem will grow taller if the concentration of gibberellin provided is also higher. If a plant is applied by gibberellin hormone, it will provide a main response of increasing the length of the stem, where an increase in the stem is caused by the activity of cell division and enlargement by gibberellin hormone (Sharfina & Yuliani, 2023). This is supported by Salisburi and Ross (1995b), which stated that the process of plant stem elongation could be accelerated by administering GA3 in optimal concentration. The administration of GA3 not only works alone but also interacts with natural auxin (endogenous) owned by plants. Based on Salisbury and Ross (1995)[b], this endogenous auxin triggers a reaction of cell elongation, which ultimately contributes to increased plant height. Besides endogenous auxin, exogenous auxin hormone can be added to increase the concentration of auxin in order to obtain optimal results of plant height growth. Thus, the treatment with a concentration of 90% shallot filtrate + 90% *Aloe vera* filtrate can indicate that there are higher auxin and gibberellin hormones than other treatments because it has the best results of plant height observation in cayenne pepper plants.

The results of this research are in accordance with research conducted by Wijaya and Adelina (2023), where if the concentration of 60% shallot extract is administered, it has a significant effect on the height of Arabica coffee seeds because administering 60% shallot extract is believed to be able to support the plant's needs for hormones called gibberellin and auxin, where these hormones are plant growth regulators. Besides being caused by shallot filtrate, there is another effect in the form of *Aloe vera* filtrate. Based on Fauzi (2021), 100 g *Aloe vera* contains 186mg of phosphorus (P). Phosphorus contained in *Aloe vera* filtrate has an important function for plants, including the process of plant photosynthesis, respiration, energy transfer and storage, as well as cell enlargement and division (Amelia *et al*., 2021). Meanwhile, according to Taufiqurrohman and Dewi (2024), the content of P element has a main role in the photosynthesis process and respiration as well as energy storage and transfer as ADP (Adenosine diphosphate), ATP (Adenosine triphosphate), DPN (Nucleotide diphosphopyridine), and TPN (Nucleotide triphosphopyridine).

A study by Srg and Hrp (2023) has shown that *Aloe vera* extract has a significant effect on plant height, with $F_{count}$ (4.9) higher than $F_{table}$ (4.2). This is supported by the study by Primasari (2019), which showed that the nutritional content of *Aloe vera* includes minerals, sugars, fatty acids, enzymes, and hormones (gibberellin and auxin). Asra *et al*. (2020) have explained that auxin has the ability to accelerate stem growth. Auxin works by stimulating cell growth through receptors in the plasma membrane and is translocated from the tip of the shoot to the area of cell elongation; moreover, gibberellin in *Aloe vera* also affects the length of stem and number of plant segments (Srg & Hrp, 2023).

Based on Permatasari *et al*. (2016), the combination of auxin and gibberellin activities can increase cell size because auxin has a role in cell division, while gibberellin has a role in cell expansion. Auxin affects the length of plant cells by stimulating certain proteins in the cell plasma membrane to pump H+ ions to the cell wall, causing the cell wall to relax and allowing the cell to elongate through the osmosis process. Then, these elongated cells resynthesize cytoplasm and cell wall material to maintain their structure.

Meanwhile, according to Gresiyanti and Rahayu (2023), GA hormone in stimulating cell elongation can be divided into two: the first is by increasing auxin hormone, and the second is by stimulating the formation of the α-amylase enzyme. Gibberellin hormone has the ability to increase the production of α-amylase enzyme involved in starch hydrolysis. This process causes the glucose level in the cell to increase, and water entering the cell is higher, so the cell experiences elongation.

The results also showed that there is an effect on the parameter of the number of leaves after being administered by natural PGR, where the concentration that has the best effect is the concentration of 90% shallot filtrate + 90% *Aloe vera*. Auxin contained in natural PGR, if in the optimal concentration, is able to stimulate a good growth of leaves. Auxin functions in the growth, elongation, and

development of cells and roots. Auxin hormone produced by active meristematic tissue (shoots, young leaves) is a growth-stimulating factor when cuttings elongate (Gardner *et al*., 1991).

Puspitasari *et al*. (2020) stated that the higher the content of endogenous GA3, the greater the number of leaves; GA3 is known as the hormone that can trigger growth, so it is also able to trigger an increase in the number of leaves. This study is strengthened by Amirudin *et al*. (2015), who stated that plant growth regulators, such as auxin and gibberellin, have an important role in growth. Auxin accelerates cell division and enlargement, which produces leaf primordia, while gibberellin has a role in leaf elongation (Roikan *et al*., 2020).

This study showed an effect of the concentration of natural PGR on the number of leaves, but the effect was not significantly different. This is in line with the study conducted by Fauzi (2021), which showed results that the number of leaves in the plant administered control treatment, concentration of 10%, and concentration of 50% showed no significant difference, so it can be stated that the non-significant effect can be due to auxin and gibberellin hormones contained in *Aloe vera* gel.

The results also showed that there was an effect on the parameter of the stem diameter after being administered by natural PGR, where the administration of natural PGR with a concentration of 90% shallot filtrate + 90% *Aloe vera* filtrate is the best concentration that can be administered in cayenne pepper plant. The higher content of auxin and gibberellin hormones in the concentration of 90% shallot filtrate + 90% *Aloe vera* filtrate can have a good effect when administered to the cayenne pepper plant and support the growth of stem diameter. This is supported by Haryati (2020), who stated that auxin and gibberellin hormones can accelerate the growth of vascular tissue and division of vascular cambium cells, which ultimately are able to accelerate the formation of stem diameter. According to Pradita *et al*. (2022), auxin in shallot extract has a significant effect on the flexibility of the cell wall. Besides, due to the presence of auxin hormone, the results of this research are also supported by Abidin (1990), where gibberellin has a role in the cambium activity and cell elongation. Moreover, Prawiranata *et al*. (1981) stated that GA3 is able to accelerate the growth of the stem and increase cell enlargement and multiplication so the plant can grow optimally.

This study also found that there were results that had an effect but were not significantly different. This is supported by Hakiki *et al*. (2018), where the growth of oil palm seedlings in pre-nursery is not significantly different between treatments that had been administrated the concentration of shallot extract of 20%, 40%, 60%, and control, which was according to the results of the Independent t-Test. Another research by Fauzi (2021) showed that the results of administering *Aloe vera* gel did not have a significant effect on the process of increasing the diameter of green bean plant stem. The main function of auxin contained in *Aloe vera* gel is to accelerate the formation of fruit, stem elongation, and root branching, but it cannot help to increase stem diameter, and gibberellin also does not have the main function of increasing stem diameter (Asra *et al*., 2020).

Of the five natural PGRs that can cause growth in the cayenne pepper plant, the treatment with a concentration of 90% can be recommended as the best natural PGR for supporting the growth of cayenne pepper. This concentration contains auxin and gibberellin hormones that exceed the hormone content in other concentrations, allowing it to provide the best result in all observation parameters.

## CONCLUSION

Based on the research results, it can be concluded that administering natural PGR made from shallot and *Aloe vera* filtrates significantly affects the growth of cayenne pepper according to plant height but does not show a significant impact on the number of leaves, and stem diameter. The best concentration for the growth of cayenne pepper is 90% shallot filtrate + 90% *Aloe vera* filtrate.

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## CONFLICT OF INTEREST

There is no conflict of interest

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