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The Effect Of Coconut Water, Onion Extract and Bamboo Boobs Extract on Robusta Coffee Seed Germination (*Coffea canephora*)

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Abstract

Background: Robusta (*Coffea canephora*) is one type of coffee widely cultivated in Indonesia and is one of the leading commodities. Coffee seeds include seeds that have a long dormancy period that inhibits the germination process. Breaking dormancy can be done by several methods, one of which is soaking in natural growth regulators. Soaking treatment with natural growth regulators can be combined with soaking time treatment to break dormancy. This study aimed to determine the combination of natural growth regulator treatment and the right soaking time for Robusta coffee seed germination. **Methods:** This research is a 3-repeat Complete Factorial Randomized Design Experiment with the first factor of natural growth regulators type, which consists of 4 levels, namely: Z0 = control; Z1 = coconut water; Z2 = onion extract and Z3 = bamboo shoots, and the second factor is the length of soaking which consists of 3 levels, namely P1 = 12 hours; P2 = 24 hours and P3 = 36 hours. **Results:** Natural growth regulators' treatment of shallot extract with 24 hours of soaking time gave the best results on all parameters. **Conclusions:** Using natural growth regulators from coconut water, shallots, and bamboo shoots with several soaking times affects all parameters observed, both in single and combined administration.

Keywords: Germination; Natural stimulants; Robusta coffee; Soaking time

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Introduction

Robusta (*Coffea canephora*) is a coffee widely cultivated in Indonesia and one of the leading commodities. Robusta coffee plants have been shown in several studies to be quite resistant to disease attacks and have a characteristic taste that is more bitter, slightly sour, and contains higher levels of caffeine than Arabica coffee (Hakim & Septian, 2011). Like other types of coffee, Robusta coffee seeds are often used as a beverage ingredient. However, not only the seeds can be used. Different parts of the coffee plant, such as the stems, leaves and fruit skin, can also be used. Indonesia is the fourth largest coffee-producing country in the world based on 2017 data, with a total of 8% of total world production, namely 639 thousand tons per year, consisting of 72.84% Robusta coffee and 27.16% Arabica coffee (Ministry of Industry Public Relations Bureau and Ministry of Communication and Information Government Communications Team, 2017).

The various benefits of the coffee plant make this plant have great potential for cultivation. Efforts can be made to increase plant production by providing sufficient and quality seeds through proper and effective handling. Coffee beans are beans that have a long dormancy period. The hard seed coat makes coffee beans take a long time to germinate. The cause of coffee bean dormancy is the complex condition of the seed coat,

which means that the water and air needed for the germination process cannot enter the beans, so germination takes a long time (Marfirani, 2014).

Soaking seeds in ZPT is one method that can be used to break seed dormancy. Growth Regulators (ZPT) are non-nutrient organic compounds active in low concentrations and can cause biochemical, physiological, and morphological responses (Tanjung, 2021). Growth Regulators (ZPT) play a role in regulating the accelerated growth of each tissue and integrating these parts to produce the desired shape (Lestari, 2011). Natural ZPT is an alternative, considering that using chemicals harms the environment and is quite expensive. PGR made from organic ingredients is more environmentally friendly, easy to obtain, safe to use, and cheaper (Novi & Rizki, 2015).

It is hoped that the use of organic materials as natural PGRs with a predetermined soaking time can overcome the problem of dormancy in Robusta coffee plants so that it can shorten the seed dormancy period by accelerating earlier germination, which is characterized by the growth of plumules and radicles. As Marano & Tandirerung (2016) did in their research using several natural PGRs in germinating Arabica coffee seeds (*Coffea arabica L.*), the results showed that the use of natural PGRs from golden snails, coconut water, bamboo shoots, banana weevils, and buffalo urine had an effect. Authentic to the age of germination. In their research, Adnyana et al. (2022) also showed that soaking robusta coffee seeds in shallot extract for 12 hours affected the germination and growth of robusta coffee seedlings. This research aims to determine the Effect of the Interaction between the type of natural PGR and the soaking time, the Effect of a single treatment of the natural PGR type, and the Effect of the long soaking treatment on the germination of Robusta coffee seeds.

Methods

This research was conducted on the Forest Plant Seed UPT Land of the East Java Provincial Forestry Service from July to November 2023.

Sample or Participant

The tools used for this research were a spatula, sprayer, measuring cup, plant marker, germination tank, meter or ruler, roasting pan, container, sieve, and scissors. The materials used in this research are 6-8 month-old Robusta coffee seeds from Jember, Lumajang sand, coconut water, shallots, bamboo shoots, water, and the fungicide Redomil.

Procedure

This research is a factorial experiment prepared using a completely randomized design (CRD) with 3 replications and two factors. Factor 1 is the type of natural PGR with four treatment levels: Z0 = control (water soaking), Z1 = coconut water, Z2 = shallot extract, and Z3 = bamboo shoot extract. Factor 2 is the length of soaking with three treatment levels consisting of P1 = 12 hours, P2 = 24 hours, and P3 = 36 hours.

Making Shallot Extract ZPT

Five hundred grams of shallots are crushed, and once smooth, 1 liter of water is added to it and placed in a clean container. The crushed shallots are then filtered using a sieve or gauze until the water and dregs are separated. The solution is ready to be used according to the treatment (Irmayanti et al., 2021).

Making ZPT Coconut Water

The young coconut water used comes from young coconuts whose outer skin is green with the characteristics of smooth and slippery fruit skin, free from pests and diseases. The coconut is peeled, and the water is taken until 1 liter is collected. Then, the coconut water

is filtered using gauze to produce clean coconut water. Coconut water is not mixed with clean water to make a 100% coconut water concentration (Sugiyatno, 2016).

Making Bamboo Shoot Extract ZPT

Making bamboo shoot extract ZPT by grinding 1 kg of bamboo shoots, then adding 1 liter of water and stirring until smooth. The bamboo shoots that have been mashed are then filtered using a sieve or gauze until the water and dregs are separated (Setyaningsih, 2021).

Planting Media Preparation

The sand planting media used in this research was sifted first to make the sand size finer and more uniform. Sand planting media is sterilized by drying it in the sun and roasting it. The sand that has been sterilized is then sprayed using the fungicide solution Redomil at a dosage of 1 gram/1 liter of water. Sterile sand can be used as a planting medium for Robusta coffee germination.

Soaking Robusta Coffee Seeds

Soaking Robusta coffee seeds is carried out simultaneously using a natural PGR solution made previously and water (as a control) with a concentration of 100% for each type of soaking ingredient. Each seed was soaked for 12, 24, and 36 hours in each treatment using a wet container. Fifty coffee seeds were soaked for each treatment. The seeds are soaked in 300 ml of PGR solution per treatment.

Robusta Coffee Seed Germination

Germinating coffee seeds is done by preparing a germination tank and then filling it with sterilized sand. The tub is divided into 50 soil holes with a 1-2 cm depth. Seeds soaked according to the ZPT-type treatment with a predetermined soaking time are sown into germination tanks filled with sand using the in-sand method. Germination samples were 50 seeds per treatment carried out with three replications, so 1,800 seeds were germinated. Germination was carried out for 110 days, and germination parameters were measured at the end of the observation.

Observation Variables

Germination Power

The calculation of germination is carried out at the end of germination, namely at the age of 110 days after the seeds are planted. According to Mulyana et al. (2012), the formula for calculating germination power is as follows:

DB = JBK/JBTx 100%

Information:
DB: Germination power
JBK: The number of seeds germinating is normal
JBT: Number of seeds planted

Maximum Growth Potential

Maximum growth potential can be calculated based on the seeds that grow every day. The research started from the first observation of sprouts appearing until the last observation of germination, namely on the 110th day, which was calculated using the maximum growth potential formula (ISTA, 2014), namely:

$$PTM = \Sigma BT/(\Sigma BD)x\ 100\%$$

Information:
PTM: Maximum growth potential
BT: Growing seeds (normal and abnormal)
BD : The seed that was planted

Vigor Index (%)

The vigor index is the number of seeds germinating from day one until the end of observation, namely day 110, calculated using the ISTA formula (2010). The formula for calculating the vigor index is:

$$IV = G1/D1 + G2/D2 + G3/D3 + ...+ Gn/Dn$$

Information:
IV: Vigor Index
G: Number of seeds that germinate on a given day
D : Time corresponding to G
n : Number of days in the final calculation

Weight of sprouts

The weight of the sprouts was measured at the end of germination, namely 110 HST. Measurements were done by destroying the sprouts, cleaning the roots from the soil, and then weighing the sprouts using an analytical balance.

Height of sprouts

Sprout height was measured at the end of germination, namely 110 HST. Measurements are made by destroying the sprouts and cleaning the roots from the soil, then measuring from the tip of the root to the point where the sprout grows using a ruler.

Data analysis

The research data were analyzed using the ANOVA test, and the minor real object test (BNJ) was continued at 5%. The linear equation model for the factorial Completely Randomized Design (CRD) is as follows (Sastrosupadi, 2000):

$$Yijk = \mu + \alpha i + \beta j + \alpha\beta ij + \varepsilon ijk$$

Information :
Yijk = observation of the α factor (type of natural PGR) i-th level (1,2,3,4), β factor (soaking time) j-th level (1,2,3), and k-th replication (1,2,3,4)
μ = General average
αi = Influence of factor α (type of natural PGR) at the ith level (1,2,3,4)
βj = Influence of the β factor (soaking time) at the jth level (1,2,3)
αβij = Interaction between factor α (type of natural PGR) and factor β (soaking time)
εijk = Effect of an error on factor α (type of natural PGR) i-th level (1,2,3,4), β factor (soaking time) j-th level (1,2,3) and k-th replication (1,2,3,4)

Further analysis is carried out using the Honestly Significant Difference Test (BNJ) at the 5% level if there is a significant difference.

Result and Disussion

Germination Power (%)

The variance analysis results showed a real interaction between the combination treatment of natural PGR types and soaking time on the germination capacity of Robusta coffee seeds. A single treatment of natural PGR type and soaking time authentically

influenced the germination of Robusta coffee seeds. The average value of germination of Robusta coffee seeds due to the combination of natural PGR types and soaking time is presented in Table 1.

Table 1. Average Germination Power (%) of Robusta Coffee Seeds due to Combination of Natural PGR Type Treatment and Soaking Time

Germination Power (%)			
Treatment	**Soaking Time (hours)**		
Types of Natural Growth Regulators (ZPT).	**12**	**24**	**36**
Control (Water Immersion)	73,33 b	80,00 bc	76,00 bc
Coconut water	71,33 ab	81,33 bc	80,66 bc
Red onion	80,00 bc	89,33 c	84,66 bc
Bamboo Shoots	73,33 b	77,33 bc	57,33 a
BNJ 5%		15,76	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNJ test.

Based on Table 1, the average germination capacity of Robusta coffee seeds shows that the best average percentage value was found in the combination of onion PGR treatment with 24-hour soaking, namely 89.33%. Still, it was not significantly different from the 12-hour shallot PGR treatment and 36-hour shallot PGR treatment, control (soaking in water) 24 hours, control (soaking in water) 36 hours, coconut water 24 hours, coconut water 36 hours, and bamboo shoots 24 hours. This is because the contents of the several types of ZPT used are different and have different functions.

Red onion ZPT has the highest germination percentage because red onions contain the hormone auxin, which plays a role in stimulating root growth. According to Kurniati et al. (2017), 100 ml of shallot extract contains the hormone auxin 10,355 ppm in the form of IAA. The hormone content can be used to stimulate seed germination. Apart from that, the length of time the seeds are soaked can also affect seed germination. The research showed that soaking PGR for 24 hours gave the best results for germination parameters. This is because 24-hour soaking is more optimal for increasing the germination percentage than 12-hour and 36-hour soaking.

Maximum Growth Potential (%)

The variance analysis results showed a very significant interaction in the combination treatment of the type of natural PGR solution and soaking time on the maximum growth potential of Robusta coffee seeds. A single treatment of natural PGR type has an authentic influence on the maximum growth potential of Robusta coffee seeds. Meanwhile, for a single treatment, the length of natural PGR soaking did not significantly affect the maximum growth potential parameters of Robusta coffee seeds. The average value of maximum growth potential for Robusta coffee seeds is presented in Table 2.

Table 2. Average Maximum Growth Potential (%) of Robusta Coffee Seeds due to Combination of Natural PGR Type Treatment and Soaking Time

Maximum Growth Potential (%)			
Treatment	**Soaking Time (hours)**		
Types of Natural Growth Regulators (ZPT).	**12**	**24**	**36**
Control (Water Immersion)	81,33 ab	88,00 b	87,33 b
Coconut water	88,00 b	90,00 b	92,00 b
Red onion	91,33 b	97,33 b	96,67 b
Bamboo Shoots	88,00 b	88,00 b	71,33 a
BNJ 5%		13,14	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNJ test.

Maximum growth potential is the percentage of all regular and abnormal seeds that are alive or show signs of life. Observation of the maximum growth potential of seeds is used to measure seed viability. The analysis of variance shows that the use of a combination of natural PGR treatment and soaking time has a significant effect on the maximum growth potential parameters of Robusta coffee seeds. The highest maximum growth potential value was obtained in the combination of red onion PGR treatment with a soaking time of 24 hours, which gave the highest results in the maximum growth potential parameter, 97.33%. Still, it was not significantly different from all treatments except bamboo shoots PGR with a soaking time of 36 hours. Like the percentage of germination capacity, the highest value for maximum growth potential is soaking the seeds in a ZPT solution of shallot extract for 24 hours. This is because the content in shallot extract is the hormone auxin and gibberellin, which play a role in germination and root growth.

Coconut water also contains auxin, so the percentage value of maximum growth potential is also high. The time the seeds are soaked in the ZPT solution influences the imbibition process in the seeds so that the absorption of the ZPT hormone content can be maximized. As stated by Pertiwi et al. (2016), the first stage of germination is the absorption of water by the seed so that the seed coat becomes soft and, at the same time, oxygen can enter the seed. Herawati (2013) added that soaking time is quite helpful for seeds in the germination process.

Vigor Index (%)

The results of the variance analysis showed that the combination treatment of the type of natural PGR solution and soaking time did not significantly affect the vigor index of Robusta coffee seeds. A single treatment of the natural PGR type had a significant effect, and the soaking time really influenced the vigor index of Robusta coffee seeds. The average value of the Robusta coffee seed vigor index is presented in Table 3.

Table 3. Average Vigor Index (%) of Robusta Coffee Seeds Treated with Natural PGR Type and Soaking Time

Treatment Types of Natural Growth Regulators (ZPT).	Vigor Index (%)
Control (Water Immersion)	1,17 [a]
Coconut water	1,26 [a]
Red onion	1,38 [b]
Bamboo Shoots	1,15 [a]
BNJ 5%	0,11
Soaking Time (hours)	
12	1,20 [a]
24	1,30 [b]
36	1,22 [a]
BNJ 5%	0,08

Note: Numbers followed by the same letter in the same column and treatment are not significantly different in the 5% BNJ test.

The vigor index is one of the parameters used to determine the ability of average seeds to grow well, be strong, and have a standard sprout structure. Vigor is defined as the ability of seeds to develop generally in suboptimal environmental conditions (Permanasari & Aryanti, 2014). According to Filho (2015), vigor seeds will more efficiently channel food reserves from the endosperm tissue to the embryonic axis, reflected in plant seeds' growth. The variance analysis showed a real influence on the single treatment of natural PGR type and soaking time. Still, there was no interaction between the combination of the two treatments. The red onion extract PGR treatment had the highest vigor index value, 1.38%, significantly different from the other treatments. The lowest vigor index value was produced by the bamboo shoot ZPT treatment, namely 1.15%, and it was not substantially

different from the control treatment (water soaking) and coconut water ZPT. According to Sadjad et al. (1999), seeds with high vigor will grow faster because the seeds germinate in a relatively short time. In their research, Al & Sulistyono (2019) also stated that soaking seeds in onion extract ZPT at a concentration of 50% gave the best results on seed vigor and germination of robusta coffee seeds. This shows that using red onion extract as a natural PGR can help Robusta coffee seeds in germination.

The soaking time of 24 hours based on the 5% BNJ test results had the highest value for the vigor index parameter with an average of 1.30% and was significantly different from the 12-hour and 36-hour soaking treatments. This shows that the soaking treatment influences germination. Sahroni et al. (2018) stated that soaked seeds have a higher germination percentage than unsoaked seeds because soaking helps provide the water needed for germination while speeding up the imbibition process in seeds. Soaking for 24 hours is optimal for the seeds to carry out the imbibition process.

Sprout Weight (grams)

The results of the variance analysis showed that the combination treatment of the type of natural PGR solution and soaking time did not significantly affect the weight parameters of Robusta coffee sprouts. A single treatment of natural PGR types had an authentic influence on the weight of Robusta coffee sprouts. In contrast, a single treatment of soaking time for natural PGRs did not impact the weight parameters of Robusta coffee sprouts. The average weight of Robusta coffee sprouts is presented in Table 4.

Table 4. The average weight of robusta coffee sprouts treated with natural PGR type and soaking time

Treatment Types of Natural Growth Regulators (ZPT).	Sprout Weight (grams)
Control (Water Immersion)	0,57 [a]
Coconut water	0,57 [a]
Red onion	0,67 [b]
Bamboo Shoots	0,56 a
BNJ 5%	0,06
Soaking Time (hours)	
12	0,59
24	0,61
36	0,57
BNJ 5%	tn

Note: Numbers followed by the same letter in the same column and treatment are not significantly different in the 5% BNJ test; tn: no real effect.

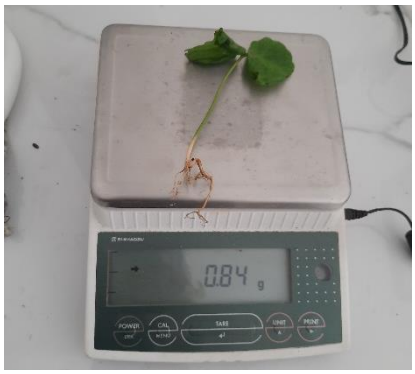

Figure 1. Measuring the weight of the sprouts

The sprout weight was measured by measuring the wet weight of regular Robusta coffee sprouts previously selected and cleaned (Figure 1). Noflindawati et al. (2017) The results of the analysis of variance and the 5% BNJ test on the sprout weight parameter

showed that the highest value was produced by sprouts treated with onion extract PGR of 0.67 grams and was significantly different from the control treatment (water soaking), coconut water PGR and bamboo shoot PGR. The single treatment of soaking time and the combination treatment of both factors did not significantly affect the weight of Robusta coffee sprouts. Shallot extract ZPT has the highest average sprout weight because it contains auxin and gibberellin, which help the plant grow. As Rajiman (2018) said, auxin functions assist in stem diameter root and growth.

Sprout Height (cm)

The variance analysis results showed a very significant interaction between the combination treatment of the type of natural PGR solution and soaking time on the height of Robusta coffee sprouts. A single treatment of natural PGR type and soaking time also had an authentic influence on the height of Robusta coffee sprouts. The average height value of Robusta coffee sprouts is presented in Table 5.

Table 5. Average Height of Robusta Coffee Sprouts Due to Combination of Natural PGR Treatment Types and Length of Soaking

Sprout Height (cm)			
Treatment	**Soaking Time (hours)**		
Types of Natural Growth Regulators (ZPT).	**12**	**24**	**36**
Control (Water Immersion)	13,06 [a]	13,07 [a]	13,96 [b]
Coconut water	13,04 [a]	13,70 [ab]	13,82 [b]
Red onion	14,35 [bc]	14,96 [c]	14,01 [b]
Bamboo Shoots	13,94 [b]	14,61 [bc]	13,56 [ab]
BNJ 5%		0,67	

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNJ test.

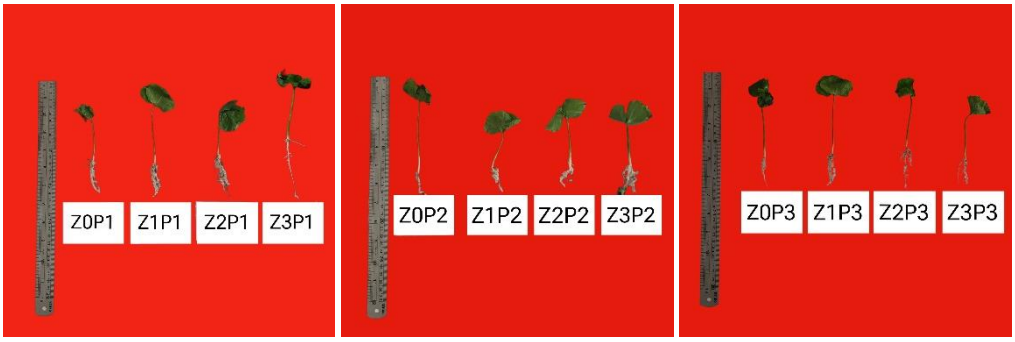

Figure 2. Results of Robusta Coffee Sprouts: Z0 (control), Z1 (coconut water), Z2 (shallot extract), Z3 (bamboo shoot extract, P1 (soaking time 12 hours), P2 (soaking time 24 hours), P3 (soaking time 24 hours). soaking time 36 hours)

The combination of soaking seeds in a PGR solution with prolonged soaking significantly affected the height of the sprouts. The results of the 5% BNJ test (Table 5) show that soaking Robusta coffee seeds in a ZPT solution of shallot extract with a soaking time of 24 hours had the highest results in the height of Robusta coffee sprouts, namely 14.96 cm. Still, it was not significantly different from the shallot PGR treatment of noon and bamboo shoots for 24 hours. Red onion ZPT also contains the hormone gibberellin, which functions in seed germination and plant root elongation. As happened in the research of Adnyana et al. (2022), soaking treatment with 100% shallot extract for 12 hours had a good effect on seed height and root length of Robusta coffee seedlings.

Conclusions

Based on the research results, using natural ZPT from coconut water, shallots, and bamboo shoots with several soaking times influences all the parameters observed in single

and combined administration. The onion extract PGR treatment with a soaking period of 24 hours showed better results than other treatments.

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Declaration statement

The authors reported no potential conflict of interest

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