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The Effect Of Concentration and Duration Of Coconut Water Soaking On the Growth Of Oil Palm Seeds in Pre-Nursery (*Elaeis Guineensis* Jacq.)

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Abstract.*This study aims to determine the effect of soaking time and coconut water concentration on the dormancy breaking of oil palm seeds (Elaeis guineensis Jacq.). This study used a Factorial Completely Randomized Design with two factors. The first factor is the concentration of coconut water (A): A1 = 25% coconut water/liter of water, A2 = 50% coconut water/liter of water, and A3 = 75% coconut water/liter of water. The second factor is the soaking time (L): L1 = 30 minutes, L2 = 60 minutes, and L3 = 90 minutes. Data analysis was conducted using variance analysis and Duncan's test. The results showed that the concentration of coconut water significantly affected germination power, germination age, plant height, and the number of leaves of oil palm seedlings. A 75% concentration of coconut water produced the best dormancy breaking of oil palm seeds. The soaking time in coconut water solution also significantly affected germination power, germination age, plant height, and the number of leaves of oil palm seedlings. A soaking time of 90 minutes resulted in the best dormancy breaking of oil palm seeds. The interaction between coconut water concentration and soaking time significantly affected the germination power of oil palm seeds. This study provides important information on the optimal soaking conditions to improve dormancy breaking success, which can be used to accelerate the germination and growth of oil palm seedlings.*

Keywords: *Coconut water; Concentration; Oil palm seeds; Soaking time*

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh waktu perendaman dan konsentrasi air kelapa terhadap pemecahan dormansi biji kelapa sawit (Elaeis guineensis Jacq.). Penelitian ini menggunakan desain faktorial acak lengkap dengan dua faktor. Faktor pertama adalah konsentrasi air kelapa (A): A1 = 25% air kelapa/liter air, A2 = 50% air kelapa/liter air, dan A3 = 75% air kelapa/liter air. Faktor kedua adalah waktu perendaman (L): L1 = 30 menit, L2 = 60 menit, dan L3 = 90 menit. Analisis data dilakukan dengan analisis varians dan uji Duncan. Hasil penelitian menunjukkan bahwa konsentrasi air kelapa berpengaruh signifikan terhadap daya berkecambah, umur berkecambah, tinggi tanaman, dan jumlah daun bibit kelapa sawit. Konsentrasi air kelapa 75% menghasilkan pemecahan dormansi biji kelapa sawit terbaik. Waktu perendaman dalam larutan air kelapa juga berpengaruh signifikan terhadap daya berkecambah, umur berkecambah, tinggi tanaman, dan jumlah daun bibit kelapa sawit. Waktu perendaman 90 menit menghasilkan pemecahan dormansi biji kelapa sawit terbaik. Interaksi antara konsentrasi air kelapa dan waktu perendaman berpengaruh signifikan terhadap daya berkecambah biji kelapa sawit. Penelitian ini memberikan informasi penting mengenai kondisi perendaman optimal untuk meningkatkan keberhasilan pemecahan dormansi, yang dapat digunakan untuk mempercepat proses perkecambahan dan pertumbuhan bibit kelapa sawit.

Kata kunci: Air kelapa; Biji kelapa sawit; Konsentrasi; Waktu perendaman

1. INTRODUCTION

Oil palm (Elaeis guineensis Jacq.) is a crucial agricultural crop, particularly in the plantation sector, due to its significant economic value. As the most productive oil crop globally, oil palm plays a vital role in the agricultural economy, especially in countries like Indonesia, where it is a superior commodity. Beyond its economic importance, oil palm oil has numerous applications, including as a substitute for kerosene and an alternative fuel for

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biodiesel, making its cultivation and production even more essential. To optimize production, high-quality seeds are required to ensure the growth of productive oil palm plants.

One of the main challenges in oil palm seed production is the dormancy of the seeds. Dormancy refers to the condition where seeds fail to germinate even under ideal conditions for growth. In the case of oil palm seeds, the hard outer shell prevents the seeds from sprouting, necessitating specific treatments to break dormancy and encourage faster germination. Dormancy is a significant hurdle in seed propagation, and overcoming it requires special techniques such as scarification or chemical treatments that facilitate the absorption of water and gases into the seed, enhancing the germination process (Sinaga et al., 2021).

Oil palm propagation is primarily generative, relying on seedling nurseries to produce healthy plants. There are two methods for establishing oil palm nurseries: one-stage and two-stage nurseries. In one-stage nurseries, seedlings are directly planted into large polybags, whereas, in two-stage nurseries, seedlings are first grown in small polybags (pre-nursery) before being transferred to larger polybags (leading nursery). The success of the nursery phase is crucial, as it determines the eventual success of oil palm plantation establishment and future production. Proper nursery management, particularly in the leading nursery stage, is essential for producing healthy seedlings that can thrive in the field (Ariyanti et al., 2022).

To facilitate successful seedling growth, certain pre-germination treatments can be applied to stimulate the germination process. These treatments increase respiration, imbibition rate, and metabolic activity, all of which are essential for seedling development. One promising treatment is soaking the seeds in coconut water, which is known to contain various growth-promoting compounds such as cytokinins, auxins, gibberellins, and kinetin. These compounds are beneficial for stimulating cell division, promoting root and shoot growth, and accelerating the germination process (Novita et al., 2023).

Coconut water, a natural growth regulator, is an affordable and readily available alternative to synthetic growth substances. It has gained popularity as an organic material for enhancing plant growth due to its lower cost compared to synthetic chemicals. Additionally, coconut water contains a range of beneficial substances such as cytokinins (including kinetin and zeatin) and auxins that promote seedling growth. The high concentrations of these compounds in coconut water can significantly improve the viability and vigor of seeds, making it an effective tool for overcoming dormancy in oil palm seeds and promoting successful germination (Srimaulinda et al., 2021; Mantra & Ketut, 2022).

2. RESEARCH METHODS

This study used a Factorial Completely Randomized Design. This study used 2 factors consisting of: Factor 1: coconut water concentration (A), namely, A1 = 25% coconut water/L of water, A2 = 50% coconut water/L of water, A3 = 75% coconut water/L of water; Factor 2: soaking time (L), namely: L1 = 30 minutes, L2 = 60 minutes, L3 = 90 minutes, each treatment was repeated 3 times. The research was implemented through seed selection. The germinated oil palm seeds were ripe and good quality seeds, namely seeds taken from oil palm fruit that had been harvested and whose fruit maturity criteria had been considered. The seeds were taken from the Tenera variety, where the skin's surface was not defective and free from pests and diseases. The selected oil palm seeds were oil palm seeds that sank when put into water. Furthermore, the application of Coconut Water was carried out, where the seeds washed with clean water were soaked in coconut water (according to treatment). The soaking treatment is carried out only once before the seeds are incubated. The next treatment is that the seeds are dried using a drying tank for 1 hour, this drying is only to dry the outside of the seeds. This drying is done using a fan installed around the drying rack. Furthermore, the germination seeds are incubated, the seeds that have been washed with clean water are soaked in coconut water (according to treatment), and after the incubation is complete, drying is carried out. The drying is done by drying. The dried seeds will then be planted in the polybags that have been provided. The observation variables carried out are germination power (%), germination age (days), seedling height (cm), and number of leaves (strands).

3. RESEARCH RESULTS

Germination Power (%)

Figure 1 shows that in the coconut water concentration treatment, the highest oil palm seed germination power was in the A3 treatment (96.30%), followed by the A1 treatment (81.48%) and A2 (88.89%). Figure 1 also shows that in the treatment of soaking time in coconut water, the highest oil palm seed germination power was in the L3 treatment (100%), followed by the L1 treatment (74.07%) and L2 (92.59%)

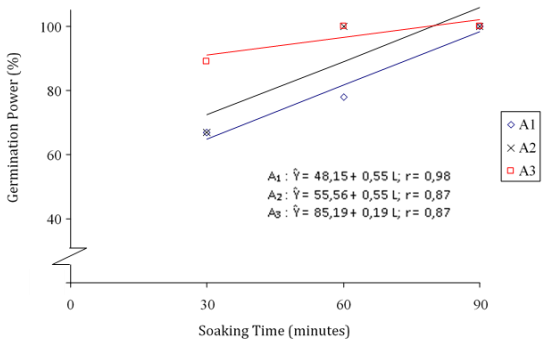

Figure 1. Effect of Interaction of Coconut Water Concentration and Soaking Time on the Germination Power of Oil Palm Seeds

Figure 1 shows that the highest increase in germination power is found in the combination of 75% coconut water concentration with a soaking time of 90 minutes, while the lowest germination power is found in 25% coconut water concentration with a soaking time of 30 minutes. The provision of young coconut water with a concentration of 25% tends to produce a germination power of 66.67% with a soaking time of 30 minutes, in contrast to the use of 75% coconut water concentration with a soaking time of 90 minutes, which produces a seed germination power of 100%. This is because the longer the soaking time, the more plant growth regulators are imbibed in the seeds; this will increase with higher coconut water concentrations (Putra *et al*., 2022). Soaking seeds in coconut water solution can accelerate the germination process because coconut water contains various growth regulators such as auxins, cytokinins and gibberellins, which can increase the germination rate in seeds. (Marjenah *et al.*, 2021) Coconut water contains natural growth hormones such as auxin, cytokinin and gibberellin, which can stimulate cell division, thus increasing seed metabolism. Increasing metabolism in seeds will further accelerate the seed germination process. The longer the oil palm seeds are soaked the more the seed germination power increases. This is because the longer the soaking, the more coconut water enters the seeds, stimulating seed growth and germination. After all, coconut water contains growth hormones. The availability of sufficient growth hormones, such as cytokinin, plays a role in cell division so that the radicle can be pushed to penetrate the endosperm (Nurhanian *et al*., 2023).

Germination Age (days)

Figure 2 shows that in the coconut water concentration treatment, the fastest germination age of oil palm seeds was in treatment A3 (12.80 days), followed by treatment A1 (13.21 days) and A2 (13.06 days). The effect of coconut water concentration on the germination age of oil palm seeds can be seen in Figure 2 below:

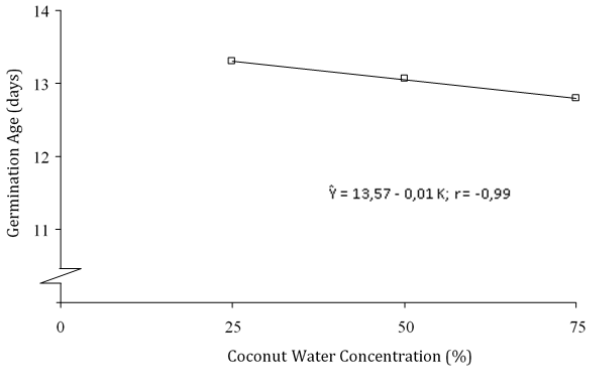

Figure 2. Effect of Coconut Water Concentration on the Germination Age of Oil Palm Seeds.

Figure 2 shows that the higher the concentration of coconut water, the faster the oil palm seeds' germination age following a negative linear regression curve. Every 25% increase in coconut water concentration can accelerate the germination age of seeds by 0.25 days (6 hours). The study results showed that the concentration of coconut water significantly affected the germination age of oil palm seeds. The fastest germination age was in the A3 treatment, at 12.80 days, and the longest in the A1 treatment, at 13.21 days. Increasing the concentration of coconut water will increase the content of growth regulators such as auxin, cytokinin and gibberellin contained in the seeds, where these growth regulators are very effective in stimulating the seed germination process. The effects of gibberellin are stimulating shoot elongation, inhibiting root growth, and breaking seed dormancy to accelerate germination in plants. (Mukarlina *et al.*, 2021) It states that coconut water contains nutrients and growth regulators such as gibberellins and cytokinins, which can stimulate germination and thus accelerate it. (Syamsiah *et al*., 2022) States that increasing plant growth regulators in seeds will accelerate the process of breaking down food reserves, which causes even transportation to all parts of the embryo so that the seeds can germinate simultaneously. Furthermore, the seeds undergo a respiration process with increased oxygen uptake and release of carbon dioxide, water and energy in heat. Increasing the respiration process in seeds will further accelerate the age of seed germination.

Figure 3 shows that in the treatment of soaking time in coconut water, the fastest germination age of oil palm seeds was in treatment L3 (12.56 days), followed by treatment L1 (13.46 days) and L2 (13.15 days). The effect of soaking time treatment on the germination age of oil palm seeds can be seen in Figure 3.

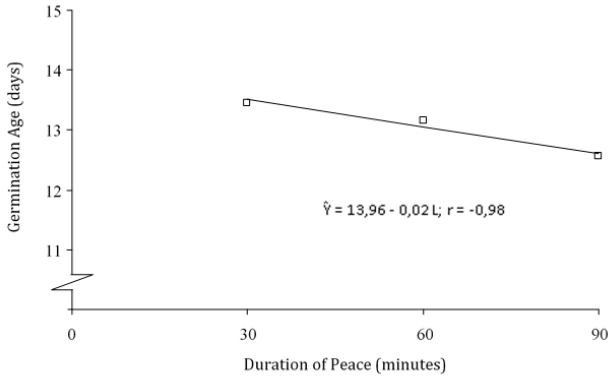

Figure 3. Effect of Soaking Time on Germination Age of Oil Palm Seeds.

Figure 3 shows that the longer the soaking in coconut water solution, the faster the germination age of oil palm seeds following a negative linear regression curve. Every increase in soaking time for 30 minutes can accelerate the germination age of seeds by 0.60 days (14.40 hours). The results showed that the soaking duration significantly affected the germination age of oil palm seeds. The fastest germination age was in the L3 treatment, at 12.56 days, and the longest in the L1 treatment, at 13.46 days. The duration of the coconut water soaking treatment can increase the seeds' water content. The main requirements for seed germination are water and oxygen. Germination in seeds begins with the entry of water into the seeds. The initial phase in seed germination is the absorption of water from the seeds (imbibition) due to the potential difference between the water in the seeds and the surrounding water. The water content of the seeds greatly influences germination and will later affect the success of seed growth. Generally, around 30-55% seed water content is needed (Mangardi *et al*., 2021).

Sprout Height (cm)

Figure 4 shows that in the coconut water concentration treatment, the highest sprouts at the age of 8 MST were in the A3 treatment (19.10 cm), followed by the A1 treatment (17.72 cm) and A2 (18.39 cm). Figure 4 shows the effect of coconut water concentration on the height of oil palm seed sprouts.

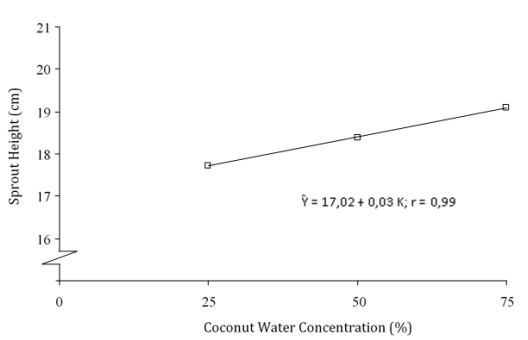

Figure 4. Effect of Coconut Water on the Height of Oil Palm Seedlings at 4 MST.

Figure 4 shows that the higher the concentration of coconut water, the higher the height of oil palm seedlings, following a positive linear regression curve. Every 25% increase in coconut water concentration can increase the height of oil palm seedlings by 0.75 cm. The study's results showed that the concentration of coconut water significantly affected the seedlings' height. The highest seedlings were in the A3 treatment at 13.89 cm and the lowest in the A1 treatment at 12.98 cm. This is because providing higher concentrations of coconut water will increase seed growth hormones. Coconut water contains gibberellin hormones that can stimulate the activity of hydraulic enzymes, especially α-amylase in seeds that play a role in the starch hydrolysis process so that the available energy is sufficient for faster root growth. (Mukarlina *et al.*, 2021) Coconut water contains nutrients and growth regulators such as gibberellins and cytokinins that can stimulate germination, thereby accelerating germination and shoot formation. Increased shoot formation will increase plant height. In addition, the auxin content in coconut water can better stimulate the process of root formation and root growth. Increasing plant root growth will increase the absorption of water and nutrients by plant roots, which will be used in photosynthesis and produce photosynthate in plant height growth.

Figure 5 shows that in the treatment of soaking time in coconut water solution, the highest sprouts at the age of 8 MST were in the L3 treatment (19.43 cm), which was significantly different from L1 (17.26 cm) and L2 (18.52 cm). The height of the sprouts in the L2 treatment was not significantly different from L1. The effect of soaking time on the height of oil palm seed sprouts can be seen in Figure 5.

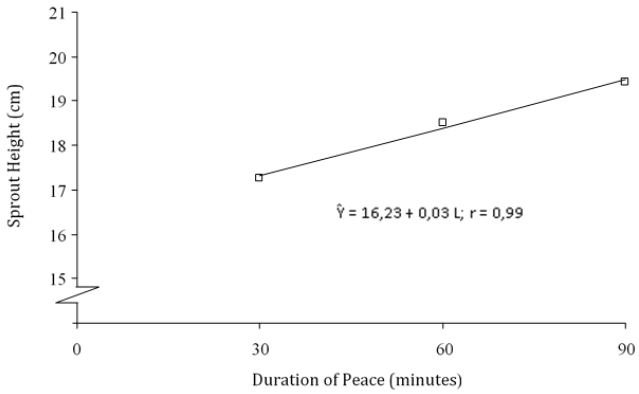

Figure 5. Effect of Soaking Time on the Height of Oil Palm Sprouts.

Figure 5 shows that the longer the soaking in coconut water solution, the higher the height of oil palm seed sprouts, following a positive linear regression curve. Every 30-minute increase in soaking time can increase the height of oil palm sprouts by 0.75 cm. The results showed that the soaking time significantly affected plant height. The tallest plants were in the L3 treatment at 14.12 cm and the lowest in the L1 treatment at 12.49 cm. Plant height is closely related to germination power. Seeds germinating earlier will affect plant height, whereas seeds germinating earlier have taller plants than seeds that germinate slowly. (Fajrin *et al*., 2023) States that the longer the seeds are soaked, the faster the seeds will germinate; this makes soaking seeds for 24 hours show the highest plant height results. (Kartina *et al*., 2023) The longer the soaking in coconut water, the more auxin enters the seed. Auxin in coconut water can affect the growth and elongation of plant cells, starting with the growth of roots and shoots. The mechanism of action of auxin will affect the elongation of cells in plants, where auxin works by affecting the flexibility of the cell wall. Plant cells then elongate due to water entering by osmosis. After this cell elongation, the cells continue to grow and resynthesize cell wall material and cytoplasm. In addition to stimulating cell elongation, auxin causes stem and root elongation.

Number of Leaves (strands)

Figure 6 shows that in the coconut water concentration treatment, the highest number of oil palm seedling leaves at the age of 8 MST was in the A3 treatment (2.33 strands), followed by the A1 treatment (1.89 strands) and A2 (2.17 strands). The effect of coconut water concentration on the number of oil palm seedling leaves can be seen in Figure 6.

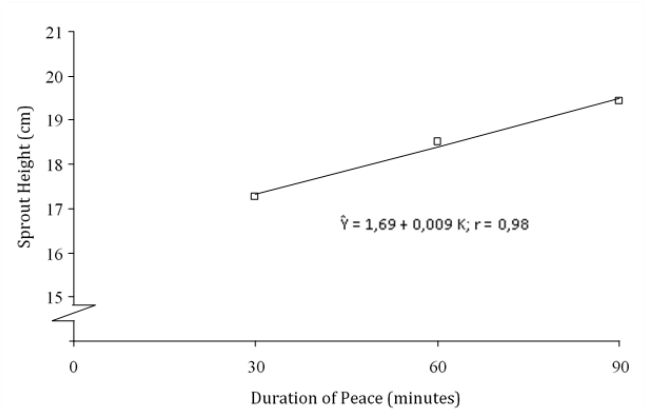

Figure 6. Effect of Coconut Water Concentration on the Number of Oil Palm Seedling Leaves at 8 MST.

Figure 6 shows that the higher the concentration of coconut water, the number of oil palm sprout leaves increases following a positive linear regression curve. Every 25% increase in coconut water concentration can increase the number of oil palm sprout leaves by 0.23 strands. The results of the study showed that the concentration of coconut water had a significant effect on the number of leaves. The highest number of leaves was found in the A3 treatment of 1.61 strands and the lowest in the A1 treatment of 1.28 strands. One of the roles of the gibberellin growth regulator contained in coconut water is for stem growth and the formation of plant leaves. The cell differentiation process will be followed to form new cells in the embryo so that the plumule, which is the future stem, is formed. The faster the stem is formed, the faster the formation of plant leaves will be (Ronaldi *et al*., 2023).

From Figure 7, it can be seen that in the treatment of soaking time, the most significant number of leaves at the age of 8 MST was in the L3 treatment (2.33 leaves), followed by the L1 treatment (1.89 leaves) and L2 (2.17 leaves). The effect of soaking time in coconut water solution on the number of oil palm seedling leaves at the age of 8 MST can be seen in Figure 7.

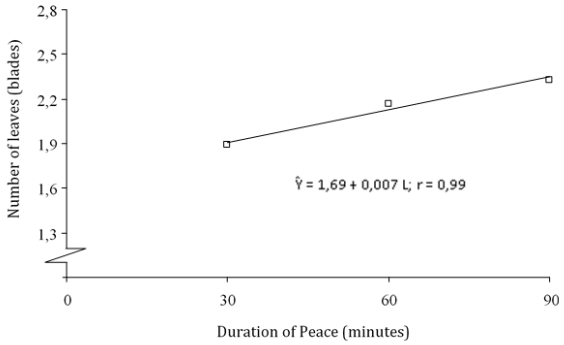

Figure 7. Effect of Soaking Time on the Number of Oil Palm Sprouts Leaves.

Figure 7 shows that the longer the soaking in coconut water solution, the more the number of oil palm seedling leaves increases following a positive linear regression curve. Every 30-minute increase in soaking time can increase the number of oil palm seedling leaves by 0.21 strands. The study's results showed that the soaking time significantly affected the number of plant leaves. The highest number of leaves was found in the L3 treatment at 1.83 strands and the lowest in the L1 treatment at 1.17 strands. This difference in the number of leaves occurs because prolonged soaking can wash substances that inhibit and soften the seed coat to produce radicles and incubation, which can standardize the germination process. The faster the seeds germinate, the faster the leaf formation will be, so the chances of the seedlings getting more leaves are greater. The height of the plant greatly influences the number of leaves; the taller the plant, the more leaves will be produced. The auxin hormone in plants and external additives stimulate plants to grow tall, thereby increasing the length of the plant and the number of leaves (Marjenah *et al.*, 2021).

CONCLUSIONS

From the above research, it was found that the treatment of coconut water concentration significantly affected the germination power, germination age, plant height, and number of oil palm seedlings. The concentration of coconut water 75% produced the best dormancy breaking of oil palm seeds. The duration of soaking in coconut water solution significantly affected the germination power, germination age, plant height, and number of leaves of oil palm seedlings. The soaking time of 90 minutes resulted in the best dormancy breaking of oil palm seeds. The interaction of coconut water concentration and soaking time significantly affected the germination power of seeds, but not significantly on the germination age, plant height, and number of leaves.

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