



RESEARCH ARTICLE

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Seed Soaking Time Modulates Germination Traits and Early Vigor of Melon (*Cucumis melo* L.)

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Abstract

Melon (*Cucumis melo* L.) is an important horticultural crop whose productivity is strongly influenced by seed quality and early seedling vigor. This study aimed to evaluate the effect of soaking duration on the germination and early seedling vigor of melon plants (*Cucumis melo* L.). The research was conducted at MARDI, Malaysia, using a completely randomized factorial design with five soaking durations (0, 2, 6, 12, and 24 hours) and three replications. Melon seeds were soaked according to the treatments, then germinated and grown in vermiculite. The observed parameters included root length, root diameter, root volume, and the number of primary and secondary roots. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's multiple range test. The results showed that soaking duration had a significant effect ($P \leq 0.05$) on all measured parameters. Seeds without soaking (0 hours) exhibited the most optimal root growth, whereas soaking for 24 hours resulted in the lowest values. Excessive soaking caused hypoxic conditions and cellular membrane damage, leading to reduced seed vigor. This study confirms the importance of optimizing soaking duration to enhance germination and early seedling vigor in melon.

Keywords: Germination, Melon, Seed Vigor, Soaking

1. Introduction

Melon (*Cucumis melo* L.) is a horticultural commodity of significant economic value, widely cultivated in tropical and subtropical regions. In Malaysia, melon, commonly known as rockmelon, is an important fruit crop due to its high market demand and nutritional value. According to data from the Department of Agriculture (2018), rockmelon production increased significantly by 45.56% between 2012 and 2018, reaching a total of 5,845.71 tons. This growth is driven by strong consumer demand for premium-quality fruit, particularly popular varieties such as 'Glamour' and 'Golden Langkawi'. Melon fruit is favored for its sweet taste, refreshing texture, and high nutritional content, including ascorbic acid, carotene, flavonoids, folate, and potassium, bioactive compounds that play an important role in maintaining health and providing antioxidant benefits (Department of Agriculture, 2018).

Despite its own potential for a big economy, power sprouts melon seeds often exhibit low-consequence mechanical dormancy. Dormancy is caused by layers of

hard skin and unripe seeds that are impermeable to water or oxygen, thereby inhibiting imbibition and reducing seed vigor. To address the issue mentioned, it is necessary to begin treatment by increasing the skin's permeability. Several techniques, such as scarification and soaking, have been implemented to accelerate germination (Rahmatika & Fitriyah, 2024). Seeds that are not able to absorb water well will remain in a dormant state, although in a physiological sense (Yuniarti & Djaman, 2015).

Germination is an important indicator of seed viability and physiological quality. According to Sadjad (2009), viability reflects the seed's ability to maintain normal metabolic activity and produce healthy sprouts. Therefore, maintaining seed viability and vigor is crucial to ensuring uniform, optimal plant growth in the field. One of the simplest and most effective techniques to increase power sprouts is to immerse seeds in water. This treatment accelerates water imbibition, which plays a role in activating important metabolic enzymes during the initial germination stage (Kurnianingsih, 2012). Water plays a

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role in the rehydration process, activating enzymes and mobilizing food reserves within seeds. During the imbibition process, water is absorbed, causing seed swelling, the seed skin softening, and the radicle appearing as a sign of beginning germination (Nurjannati, 2017; Berlian et al., 2016; Syifa et al., 2020; Lubis et al., 2014).

However, soaking seeds for too long can cause hypoxia (oxygen deprivation) in the seed tissues, which can damage cell membranes and inhibit physiological activity. This results in a decline in sprout vigor and seed vitality. Therefore, it is important to determine the optimal soaking time to ensure seeds absorb sufficient water without incurring physiological damage. This study aims to investigate the effect of soaking time on the germination and seed vigor of melon plants (*Cucumis melo L.*) and to identify the optimal soaking duration for achieving vigorous and uniform seed growth.

2. Material and Methods

This research was carried out at the Horticulture Research Center, Mardi Headquarters, Persiaran MARDI UPM, Selangor, Malaysia, at an altitude of 48 Mdpl, coordinates 2.997622 °N, 101.690619 °E.

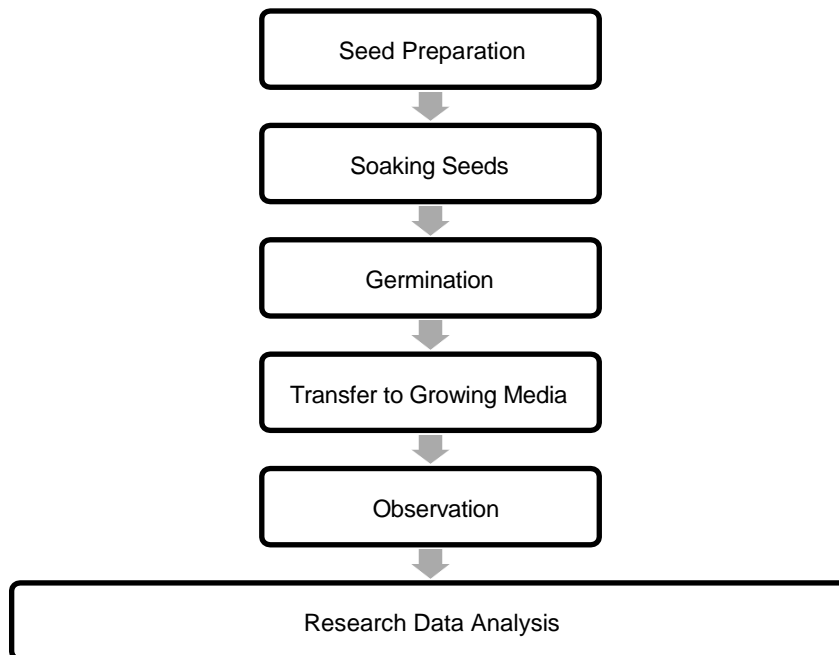
This research was conducted on September 23 - October 3, 2025. Materials used in this study include melon plant seeds (*Cucumis melo L.*), water, moist tissue, and vermiculite planting media. Meanwhile, the tool used

consists of a petri dish, a tube centrifuge cone (Falcon 50 mL), a sprayer, a plastic container, a digital camera, a permanent marker, and a device scanner, Epson Perfection V850, root equipped with the software WinRHIZO, for analysis of root morphology.

This study uses Factorial Completely Randomized Design (CRD) with one main factor, namely the duration of soaking seeds, which consists of the above five levels of treatment: Each treatment was repeated up to 3 times, yielding 15 test units. The procedure study began with seed preparation and treatment immersion, in accordance with the time elapsed, as determined. After soaking finished, seeds were checked to ensure nothing was rotten or damaged, then germinated on damp tissue inside a petri dish. Tissue is kept moist to support ongoing germination.

The seeds that have shown plumule growth after 3 days of germination (3 HSP) are transferred to vermiculite in the planting medium. Observation was carried out 10 days after germination (10 DSP) on growth parameters: long root (mm), average root diameter (mm), root volume (mm³), number of primary roots, and number of secondary roots.

The results of the observation data were analyzed using variation analysis (ANOVA), and if there is a real difference between treatments, the analysis will be continued with further testing, Duncan's Multiple Range Test (DMRT) at the level of significance 5% ($P \leq 0.05$).



Pictures 1. Research Flow Diagram

3. Results and Discussion

3.1. Root Length (mm)

Based on Table 1, the duration of seed immersion significantly influences the length of primary roots of rockmelon plants ($P \leq 0.05$). An unfertilized seed's

experience of soaking (0 hours) produces the longest root, namely 50.82 mm, whereas increased immersion time shows a decrease in root length. The lowest value obtained in the treatment immersion for 24 hours was 23.51 mm for the long root. Declining pattern: This shows that soaking

for too long can disrupt the balance between oxygen and water within the seed network, so that activity lowers respiration and slows radicle growth during the imbibition phase. According to Hossain et al. (2020), prolonged imbibition causes hypoxia, which can suppress the activity of germination enzymes such as α -amylase and dehydrogenase, thereby slowing root elongation. The results are in line with those of Khan et al. (2021) on

Cucumis sativus plants, which reported that immersion of seeds for more than 12 hours results in a decline in long root length of up to 40% due to excess water in the embryonic tissue, inhibiting oxygen diffusion and cellular metabolism. Thus, prolonged soaking can reduce seed vigor and inhibit the initial growth of melon sprouts.

Table 1. Total soaking time, seed to top length (mm), average diameter (mm), volume (mm³), total primary and secondary roots for rockmelon plant (*Cucumis melo* L.)

Number of samples	Soaking Duration (Minutes)	Root Length (mm)	Average Root Diameter (mm ³)	Root Volume	Number of Primary Roots	Number of Secondary Roots
18	0 (T ₀)	50.82 ± 0.01 ^a	0.47 ± 0.01 ^a	0.09 ± 0.01 ^a	129.89 ± 0.01 ^a	225.94 ± 0.01 ^a
18	2 (T ₁)	43.57 ± 0.01 ^b	0.42 ± 0.01 ^b	0.07 ± 0.01 ^b	96.00 ± 0.01 ^b	161.06 ± 0.01 ^b
18	6 (T ₂)	39.31 ± 0.01 ^c	0.40 ± 0.01 ^c	0.06 ± 0.01 ^c	75.88 ± 0.01 ^c	132.47 ± 0.01 ^c
18	12 (T ₃)	33.34 ± 0.01 ^d	0.38 ± 0.01 ^d	0.05 ± 0.01 ^d	63.28 ± 0.01 ^d	99.94 ± 0.01 ^d
18	24 (T ₄)	23.51 ± 0.01 ^e	0.35 ± 0.01 ^e	0.04 ± 0.01 ^e	42.65 ± 0.01 ^e	64.71 ± 0.01 ^e
Average		38.26	0.40	0.06	82.05	137.69
CV (%)		8.17	4.36	12.36	9.44	9.3

The value in the column labeled with a different letter shows a significant difference based on Duncan's Multiple Range Test (DMRT) at the confidence level $P \leq 0.05$.



Figure 2. Research documentation of rockmelon plant (*Cucumis melo* L.)

3.2. Average Root Diameter (mm)

Based on Table 1, the duration of seed immersion significantly influences the average root diameter ($P \leq 0.05$). Seeds that do not soak (0 hours) produce the largest root diameter (0.47 mm), while increasing the soaking time causes a significant decrease in root diameter—the smallest value obtained in the 24-hour treatment, with a root diameter of 0.35 mm. The pattern of root decline shows that soaking for too long can damage the cell membranes of the seeds. Prolonged water saturation can damage the integrity of the plasma membrane, disrupt cellular function, and inhibit the activity of essential enzymes during germination. As a result, the division and elongation processes of cells are not optimal, leading to inhibited root growth. According to Suita and Syamsuwida (2015), immersion seeds for too long can cause water saturation in the seed tissue, which can damage the structure of cell membranes. This results in disruption of ion exchange and

metabolic activity, ultimately leading to a decline in Power sprouts and growth roots.

3.3. Root Volume (mm³)

Based on Table 1, the duration of seed immersion significantly influences root volume ($P < 0.05$). Seeds that do not soak (0 hours) produce the largest root volume, namely 0.09 mm³, whereas increasing the soaking time causes a significant decrease in root volume. The lowest value was obtained with 24 hours of treatment immersion, with a root volume of 0.04 mm³. The pattern of subsidence shows that soaking for too long can lead to water saturation of the seeds, which can cause decay and damage embryonic tissue. When the seed absorbs more water than it needs, the mobile respiration process can be disturbed, leading to cell death in young root tissue. According to (2022), the longer the immersion time, the more fluent the endosperm tissue becomes, increasing the risk of physiological damage and

seed decay. These conditions can reduce the seed's ability to form an optimal root system during germination.

3.4. Number of Primary Roots

Duration of seed immersion has a significant effect on long primary roots ($P \leq 0.05$). Seeds that do not soak (0 hours) produce a significant amount of primary root (129.89), while increasing immersion time causes a significant reduction in primary root. The lowest value was recorded at 24 hours of immersion (42.65). The pattern of decline shows that excessive immersion can damage the enzyme cells in the seeds. According to Afdharani et al. (2019), seeds need to be immersed at the right time to accelerate growth and metabolism, thereby influencing the activity of enzymes that enable cell division during germination.

3.5. Number of Secondary Roots

Based on Table 1, the duration of seed immersion significantly influences the number of secondary roots ($P \leq 0.05$). Seeds that are not soaked (0 hours) produce the highest number of secondary roots, averaging 225.94. In contrast, increasing the soaking time significantly decreases the number of secondary roots. The lowest value was observed in seeds soaked for 24 hours, with an average of 64.71 secondary roots. This declining pattern indicates that prolonged soaking can disrupt the hormonal balance in seeds. Excessive water saturation due to extended

immersion can alter the ratio between the hormones gibberellin (GA) and abscisic acid (ABA) in the embryo, which play crucial roles in root elongation and differentiation. Hormonal imbalance can suppress meristematic cell activity and inhibit the formation of secondary roots. According to Widiatmanta et al. (2024), insufficient soaking time prevents seeds from absorbing sufficient water to initiate physiological activity, whereas excessive soaking leads to overhydration and hormonal disruption, resulting in reduced sprouting vigor and initial growth. Consequently, this variation affects germination rates among seeds, thereby impacting growth uniformity and seed quality.

4. Conclusion

Rockmelon seeds have a significant effect on early root growth, with increased immersion period reducing the length, diameter, volume, and number of primary and secondary roots. Seeds without immersion exhibit the most vigorous root growth, while immersion for 24 hours results in the weakest growth.

Further studies are recommended to examine the relationship between the imbibition period and seed structural morphology, particularly testa thickness and the embryo's permeability to water and oxygen. This approach will help understand the mechanisms that determine the optimal immersion period for rockmelon seed germination.

References

- Afdharani, R., Hasanuddin, H., & Bakhtiar, B. (2019). Pengaruh bahan invigorasi dan lama perendaman pada benih padi kadaluarsa (*Oryza sativa* L.) terhadap viabilitas dan vigor benih. *Jurnal Ilmiah Mahasiswa Pertanian*, 4(1), 169-183. <https://doi.org/10.17969/jimfp.v4i1.10361>
- Department of Agriculture Malaysia. (2018). *Fruit crop statistics* (hlm. 11-21).
- Kurnianingsih, N. (2012). Pengaruh suhu dan lama perendaman dalam air terhadap perkecambahan biji ki hujan (*Samanea saman*). *Skripsi*. Fakultas Sains dan Teknologi.
- Lasut, K. Y. H., Pinaria, A., & Raintung, J. (2022). Pengaruh konsentrasi KNO_3 dan lama perendaman terhadap perkecambahan. [*Nama jurnal tidak lengkap*], 3, 99-107.
- Lubis, A., Riniarti, M., & Bintoro, A. (2014). Pengaruh lama waktu perendaman dengan air terhadap daya berkecambah trembesi (*Samanea saman*). *Jurnal Sylva Lestari*, 2(2), 25-32.
- Muhamad, H. M. H., Muhamad, N. H., Yahya, A., & Juju, J. N. (2023). Penghasilan rockmelon yang toleran terhadap kemasinan melalui teknik cantuman untuk meningkatkan kualitas buah dengan aplikasi NaCl. *Buletin Teknologi MARDI*, 36, 101-115.
- Muhamad, H. M. H., Awang, Y., Jaafar, N. J., Sayuti, Z., Othman, N. M., Mohamad Sabdin, H. Z., & Nazli, H. M. (2022). Effects of salinity sources on growth, physiological process, yield, and fruit quality of grafted rock melon (*Cucumis melo* L.). *Pertanika* *Journal of Tropical Agricultural Science*, 45(4), 919-941.
- Nurjannati, K. (2017). Efek perlakuan priming terhadap performa tanaman cabai (*Capsicum annum* L.) pada kondisi stres air. *Skripsi*. <https://eprints.uny.ac.id/53490/1/SKRIPSI.pdf>
- Rahmatika, W., & Fitriyah, N. (2024). Stimulasi pertumbuhan awal benih melon (*Cucumis melo* L.) melalui skarifikasi dan giberelin. 24(3), 41-44.
- Sadjad. (2009). *Kuantifikasi metabolisme benih*. PT Gramedia.
- Syifa, T., Isnaeni, S., & Rosmala, A. (2020). Pengaruh jenis pupuk anorganik terhadap pertumbuhan dan hasil tanaman sawi pagoda (*Brassica narinosa* L.). *AGROSCRIPT: Journal of Applied Agricultural Sciences*, 2(1), 21-33. <https://doi.org/10.36423/agroscript.v2i1.45>
- Widiatmanta, J., & Wibowo, S. A. (2024). Efektivitas ekstrak bawang merah (*Allium ascalonicum* L.) dengan periode perendaman terhadap invigorasi benih kedelai (*Glycine max* L.). *VIABEL: Jurnal Ilmiah Ilmu-Ilmu Pertanian*, 18(2), 106-114.
- Rahmatika, W., Fitriyah, N. F., Imadudin, A., & Mardiana, Y. (2024). Pengaruh skarifikasi dan perendaman giberelin pada perkecambahan melon (*Cucumis melo* L.).
- Yuniarti, N., & Djaman, D. (2015). Teknik pengemasan yang tepat untuk mempertahankan viabilitas benih bakau (*Rhizophora apiculata*). Dalam *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, 1(6), 1438-1441.