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GERMINATION OF NUTMEG SEEDS (*Myristica argentea* Warb) IN VARIOUS MEDIA WITH SCARIFICATION TREATMENT

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ABSTRACT

Nutmeg has considerable potential to enhance the local economy, especially in the Papua region, where it is primarily cultivated in the Fakfak Regency and commonly known as Fakfak Nutmeg. One of the major challenges in nutmeg cultivation is the extended seed germination period, which limits the availability of high-quality planting materials. Typically, untreated nutmeg seeds germinate within 2 to 3 months after planting, whereas scarified seeds germinate more quickly, in approximately 1.5 months. This study aimed to evaluate the effects of different growth media and seed coat scarification on nutmeg seed germination. A randomized factorial design was employed, with seed coat treatment and growth medium. The observed variables included germination percentage, germination rate, peak value, average daily germination, seedling height, number of leaves, number of roots, and stem weight. The results showed that scarification had a significant effect on germination, particularly in terms of germination percentage, average daily germination, germination rate, and peak value. However, it did not significantly affect other growth parameters such as seedling height, number of leaves, number of roots, or stem weight. No significant differences in germination performance were observed between sand and soil media.

Keyword: *growth media, Papua nutmeg, seed germination, scarification*

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ABSTRAK

[PERKECAMBAHAN BENIH PALA (*Myristica argentea* Warb) PADA BERBAGAI MEDIA DENGAN PERLAKUAN SKARIFIKASI] Pala memiliki potensi besar untuk meningkatkan perekonomian lokal, khususnya di wilayah Papua, di mana tanaman ini terutama dibudidayakan di Kabupaten Fakfak dan dikenal sebagai Pala Fakfak. Salah satu tantangan utama dalam budidaya pala adalah lamanya waktu perkecambahan benih, yang membatasi ketersediaan bahan tanam berkualitas. Umumnya, benih pala yang tidak diberi perlakuan memerlukan waktu 2 hingga 3 bulan untuk berkecambah, sedangkan benih yang mengalami skarifikasi dapat berkecambah lebih cepat, yaitu sekitar 1,5 bulan. Penelitian ini bertujuan untuk mengevaluasi pengaruh media tanam dan skarifikasi kulit biji terhadap perkecambahan benih pala. Penelitian menggunakan rancangan acak lengkap pola faktorial, dengan perlakuan skarifikasi kulit biji dan jenis media tanam. Variabel yang diamati meliputi persentase kecambah, laju perkecambahan, nilai puncak, rata-rata kecambah harian, tinggi semai, jumlah daun, jumlah akar, dan bobot batang. Hasil penelitian menunjukkan bahwa skarifikasi memberikan pengaruh nyata terhadap perkecambahan, khususnya persentase kecambah, rata-rata kecambah harian, laju perkecambahan, dan nilai puncak. Namun, skarifikasi tidak berpengaruh nyata terhadap parameter pertumbuhan seperti tinggi semai, jumlah daun, jumlah akar, dan bobot batang. Tidak terdapat perbedaan yang signifikan dalam kinerja perkecambahan antara media pasir dan tanah.

Kata kunci : *media tumbuh, pala Papua, perkecambahan benih, skarifikasi*

INTRODUCTION

Nutmeg (*Myristica fragrans* Houtt) is an indigenous Indonesian spice crop that holds significant economic importance in both national and international markets. Indonesia currently supplies approximately 75% of global nutmeg demand (Alihya, 2021), positioning it as a leading exporter of this commodity. Among the prominent nutmeg-producing regions is Fakfak Regency, located in the Papua region of eastern Indonesia. The nutmeg cultivated in this area is locally referred to as Fakfak Nutmeg and includes several species such as *Myristica argentea* (Papuan nutmeg), *Myristica fatua* (wild nutmeg), and *Myristica fragrans* (Banda nutmeg). Additionally, a local ecotype known as *peranak*, believed to be a natural hybrid between *M. argentea* and *M. fragrans*, is also recognized in the region. Fakfak nutmeg typically thrives at elevations of approximately 700 meters above sea level (Dewi *et al*., 2017).

The strategic development of nutmeg in Papua has garnered attention from the Indonesian government, particularly within the framework of the National Medium-Term Development Plan (2020–2024). One of the key strategies is strengthening regional economic centers through the development of downstream nutmeg industries, especially in the Fakfak and Kaimana Regencies, as outlined in Presidential Regulation No. 18 of 2020. However, one of the major challenges in supporting this initiative is the limited availability of high-quality planting materials, primarily due to the prolonged dormancy period of nutmeg seeds.

Nutmeg seeds possess a hard seed coat that impedes water absorption, thereby delaying germination. Pre-germination treatments are therefore essential to overcome seed dormancy. One widely used technique is scarification, which involves mechanically weakening the seed coat to facilitate water uptake. Previous studies (e.g., Nurlailah *et al*., 2010) have demonstrated that scarification can enhance germination rates, seedling vigor, and early growth performance.

In addition to seed treatment, the choice of germination medium also plays a critical role in seedling development. Aranto *et al*. (2018) reported improved germination performance in media composed of sawdust and sand mixtures, while Zahra & Isla (2023) found that combinations of soil, organic matter, and soaking treatments significantly enhanced germination outcomes. These findings highlight the importance of optimizing both scarification methods and growing media to improve seedling establishment.

Based on this context, the present study aims to investigate the combined effects of seed coat scarify-cation and different growth media on the germination performance of nutmeg seeds, with the goal of supporting efforts to improve seedling quality and accelerate nutmeg cultivation in Papua.

MATERIALS AND METHODS

This research was conducted over a six-month period, from October 2022 to April 2023, at the Fakfak Women's Dormitory in Amban, Manokwari. The equipment used in this study included sandpaper, rulers, labeling paper, digital scales, plastic containers (3-liter capacity), and a digital camera. The materials consisted of nutmeg seeds sourced from Fakfak Regency, as well as soil, sand, and water used for the growing media.

The experiment was arranged in a Factorial Completely Randomized Design (CRD) with two factors. The first factor was seed scarification (K) with two levels: $K_{1:}$ Scarified seeds, and K_2: Unscarified seeds. The second factor involved different growth media (details of media types should be included here if available). Each treatment was replicated appropriately

Seed selection and preparation

Nutmeg seeds were collected from healthy, disease-free parent trees. Selected seeds were of small to large size, somewhat round and symmetrical in shape, with blackish-brown, shiny seed coats. Seeds were thoroughly washed before the scarification process. Scarification was performed using sandpaper to thin the seed coat and facilitate water absorption.

Planting procedure

All planting tools and containers were cleaned before use. Planting containers were filled with growth media according to the designated treatment. Scarified and unscarified seeds were planted at a depth of 1 cm with spacing of 5 cm × 5 cm. The seeds were maintained through regular watering throughout the germination period until the end of the experiment.

Observation and data collection

Observations began one week after planting and continued until 14 weeks after planting. The variables observed included:

Germination percentage (%)

The germination percentage (%) is determined based on the formula :

$$\text{Germination Percentage} = \left(\frac{\text{Number of normal seedlings}}{\text{Total number of seeds planted}}\right) \times 100$$

Germination Rate (days)

Based on the average number of days required for radicle and plumule emergence (Sutopo, 2002):

$$\text{Germination Rate} = \frac{(N_1T_1 + N_2T_2 + \ldots + N_xT_x)}{\text{Total number of germinated seeds}} \times 100$$

Where:
N = number of seeds germinated in a given time interval
T = days since planting during each interval

Peak value (%/day)

The peak value indicates the germination percentage at the point where germination starts to decline, relative to the time taken to reach that point:

$$\text{Peak Value} = \left(\frac{\text{Germination percentage at peak}}{\text{Days to reach peak}}\right) \times 100$$

Average daily germination (%)

The average number of seeds germinated per day as a percentage of total:

$$\text{Average Daily Germination} = \left(\frac{\text{Germination percentage}}{\text{Total number of observation days}}\right) \times 100$$

Seedling height (cm)

Measured from the base of the seedling to the tip of the tallest leaf at the end of the observation period.

Number of leaves

Total leaves per seedling were counted for each treatment replicate at the end of the observation period.

Number of roots

The number of roots per seedling was counted at the end of the experiment.

Seedling weight (g)

Seedlings were carefully removed from the medium, rinsed with water to remove soil, drained, and then weighed to determine fresh weight.

Data Analysis

The collected data were analyzed using analysis of variance (ANOVA) to assess the effects of the treatments. If significant differences were found, the means were further compared using the Honestly Significant Difference (HSD) test at a 5% significance level.

RESULTS AND DISCUSSION

Biophysical and Genetic Influences on Germination

The biophysical environment plays a fundamental role in plant development, particularly during the germination stage. Biophysical factors encompass plant adaptability to environmental conditions such as altitude, soil type, and humidity (Wattimena & Makaruku, 2022). Additionally, genetic traits significantly influence seed germination behavior and seedling performance. Nutmeg, being a recalcitrant seed with a hard seed coat, requires favorable physical and physiological conditions to initiate germination effectively.

Effect of scarification treatment

Nutmeg seeds possess a thick and hard seed coat that impedes water absorption, resulting in prolonged dormancy. Scarification is commonly employed to overcome this dormancy by mechanically thinning the seed coat to enhance water permeability. The analysis of variance revealed that scarification significantly improved germination percentage, although the germination rate showed less variation between treatments.

Scarified seeds exhibited a germination percentage of 58.3%, which was substantially higher than the 35.6% observed in non-scarified seeds. The mean germination time for scarified seeds was 86 days, compared to 110 days for non-scarified seeds (Table 1), indicating that scarification accelerates the germination process.

These findings align with Hartawan (2016), who reported that scarification enhances water absorption by increasing the surface area of the seed in contact with moisture. Wijaya (2023) further emphasized that scarified seeds tend to initiate radicle emergence earlier, contributing to improved germination vigor and seedling height. Similarly, Damara *et al.* (2021) reported a germination rate of 96.06% for fully scarified nutmeg seeds, significantly higher than untreated controls. In this study, scarified seeds also showed higher average daily germination (0.67%) compared to non-scarified

Table 1. Effect of scarification treatment on nutmeg seed germination and seedling growth variables

Observation Variable	Scarified Seeds (K_1)	Non-Scarified Seeds (K_2)
Germination Percentage (%)	58.3^a	35.6^b
Mean Germination Time (days)	85.5^a	110.0^b
Germination Peak Value (% per day)	0.012^a	0.009^b
Average Daily Germination (% per day)	0.664^a	0.320^b
Seedling Height (cm)	17.9	15.1
Number of Leaves (strands)	4.5	3.4
Number of Roots	16.7	12.9
Stem Fresh Weight (g)	26.8^a	21.9^b

Note : Different superscript letters within the same row indicate significant differences at $p < 0.05$

seeds (0.03%), suggesting superior seedling vigor and early growth potential.

Effect of planting media

The choice of planting media significantly influenced germination performance and seedling development. Soil-based media (M_2) exhibited the highest germination percentage (56.0%), outperforming sand-based media (M_1), which had a lower germination rate of 44.0% (Table 2). The superior performance of soil media is attributed to its higher nutrient content and better water-holding capacity, which are critical for seed metabolic activity during germination. These findings are consistent with Herliana *et al.* (2021), who found that media with a high topsoil component promoted better vegetative growth in sweet potatoes.

In contrast, the sand medium (M_1) demonstrated a faster mean germination time (84 days) com-pared to M_2 (soil), M_3 (1:1 soil–sand), and M_4 (2:1 soil–sand), the latter having the longest mean germination period (109.8 days). While sand drains well and maintains aeration, its limited water retention capacity under high temperatures may cause rapid moisture loss, potentially compromising germination consistency.

Table 2. Effect of planting media on nutmeg seed germination variables

Observation Variables	M_1 (Sand)	M_2 (Soil)	M_3 (Sand:Soil 1:1)	M_4 (Sand:Soil 2:1)
Germination Percentage (%)	44.0	56.0	46.7	48.0
Mean Germination Time (days)	84.0^{b}	88.5^{ab}	100.8^{ab}	109.8^{a}
Germination Peak Value (% per day)	0.012	0.012	0.010	0.010
Average Daily Germination (% per day)	0.540	0.624	0.470	0.441

Note : Different superscript letters within the same row indicate significant differences at $p < 0.05$

La Mente *et al.* (2020) observed that nutmeg seeds in sand began germinating at 25 days after sowing, with an average duration of 51 days, likely influenced by specific microclimatic factors. Ricardo *et al.* (2025) emphasized the role of localized microclimates—including temperature and humidity—in determining seedling performance. High porosity in sand allows for greater airflow but may lead to excessive evaporation, which can either trigger or hinder germination depending on external temperature and humidity conditions.

Nutmeg seeds require high relative humidity (60–80%) to initiate metabolic processes essential for germination (Ruhnayati & Martini, 2015). Febriyan & Widayat (2015) also found that sand media could significantly enhance nutmeg seed germination, though success remains variable without additional inputs. This variability highlights the importance of optimizing media composition.

Interaction of media and scarification on seedling growth

The interaction between scarification and media composition also significantly influenced seedling morphology. The tallest seedlings (18.3 cm) and greatest number of leaves (4.9) were observed in sand media (M_1), while this medium also produced the highest root count (17.9) and stem biomass (26.6 g) (Table 3). In contrast, M_3 (1:1 soil–sand) consistently showed the lowest performance across several variables, possibly due to suboptimal water retention or nutrient availability.

These outcomes are in line with Wiryawan *et al.* (2017), who demonstrated that mixed planting media containing organic material and topsoil can enhance aeration, root penetration, and nutrient availability. Similarly, Putri *et al.* (2021) emphasized the role of media porosity and water retention capacity in influencing germination and early seedling vigor. Yulistian *et al.* (2020) noted that poor drainage and limited nutrient access could constrain root development, thereby impairing shoot growth.

Research by Safriah *et al.* (2021) found that a 1:1 sand–soil medium supports root development, while Sartika *et al.* (2023) confirmed that sand media outperformed sawdust and husk mixtures in promoting seedling growth of other tropical species such as mangosteen. Sumiasri and Setyowati (2006) observed similar patterns in ebony seedlings, attributing enhanced root development to sand's high porosity.

Despite the benefits of scarification and sand media, nutmeg seeds germinated slowly and inconsistently, especially in media lacking organic inputs or hormonal stimulants. Studies by Taryana & Sugiarti (2019) and Agurahe *et al.* (2019) support the use of growth regulators such as gibberellins and organic amendments to improve germination rates and seedling vigor. Arianto *et al*. (2018) demonstrated that gibberellin treatment accelerated germination onset to as early as 18 days post-sowing in sand media.

Table 3. Effect of planting media on early growth performance of nutmeg seedlings

Observation Variables	M_1 (Sand)	M_2 (Soil)	M_3 (Sand:Soil 1:1)	M_4 (Sand:Soil 2:1)
Seedling Height (cm)	16.5	18.3	15.1	17.3
Number of Leaves (strands)	3.0	4.9	4.2	4.0
Number of Roots	17.9	16.6	11.3	15.2
Seedling Fresh Weight (g)	26.6	25.0	23.3	24.2

Environmental considerations

Environmental factors—including altitude, soil type, rainfall, and temperature—also modulate nutmeg germination and growth. Nutmeg can thrive at Elevations up to 700 meters above sea level, depending on the cultivar. Wattimena *et al*. (2023) reported that 80% of nutmeg cultivation in Maluku occurs between 0–100 meters above sea level, with suboptimal productivity observed beyond 700 meters. Therefore, optimizing environmental compatibility is essential for maximizing the benefits of media and seed treatment strategies.

CONCLUSION

Scarification significantly enhanced the germination performance of nutmeg (*Myristica fragrans* Houtt.) seeds, resulting in earlier and more uniform emergence than untreated seeds. The highest germination percentage (56.0%) was observed in seeds sown in sand and soil media. Among the tested media, soil yielded the tallest seedlings and the greatest number of leaves, whereas sand promoted the highest root count and biomass accumulation. These findings underscore the critical role of seed scarification and appropriate planting media in optimizing nutmeg seedlings' germination and early growth.

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