RESEARCH ARTICLE

Comparative Analysis Study of Seed Viability and Germination Behaviour of *Terminalia bellirica* Across Different Pre-Treatments and Nursery Management in Southern Region

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ABSTRACT:

Terminalia bellirica Roxb., a versatile tree of ecological, medicinal, and sericultural significance, faces propagation constraints due to seed dormancy and poor germination. The paper examines the impact of varying pre-sowing, i.e., Hot Water Treatment (HWT), Overnight Soaking (OS), and Acid Treatment (AT), on seed viability, germination, and early seedling growth during semi-controlled nursery establishment at the Forest College and Research Institute, Mettupalayam. The seeds treated under HWT conditions (80 °C, 10 min) had the highest percentage of germination (68.2), the quickest emergence (12.3 days), and a high seedling vigor index (893.4) compared to the other seed treatments (OS and AT). On the other hand, the control (untreated seeds) had 20% germination, which was very weak. Uniform growth was achieved through nursery management practices, including sterilized potting media, drip irrigation, shade nets, and integrated pest management. These results also indicate that pre-sowing thermal and hydration treatments substantially improve the efficiency of T. bellirica propagation, which has immense potential to extend its cultivation on a large scale for use in afforestation and the conservation of biodiversity, as well as in sericulture-based agro-forestry projects. Implementation of more efficient, streamlined nursery practices might be an important and significant help in improving seedling quality and thereby promoting sustainable rural survival.

Keywords: *Dormancy-breaking treatment, Nursery propagation, Seed germination, Seedling growth performance, Terminalia bellirica*

INTRODUCTION:

Terminalia bellirica (also known as Bahera or Beleric) is a tree species with a mammoth ecological, medicinal, and economic impact. It is a deciduous tree. It belongs to the Combretaceae family and is very common in the Indian subcontinent, Southeast Asia, and regions of Australia. Incorporation of *Terminalia bellirica* in the sericulture systems may have several advantages. It has hardiness and a wide range of growth across various agroclimatic conditions, making it a good candidate for raising silkworms, especially species such as tasar silkworms (*Antheraea mylitta*), which are reported to feed on various host plants (in forest environments) (Ramesh *et al*., 2005).

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In addition, it is nutritive, with more nutrients in the tree's leaves, not forgetting that it has the potential to improve the growth and productivity of silkworms, thus resulting in better quality and yield of silk. Nevertheless, successful sericulture production would not be achieved without a good understanding of Terminalia bellirica nursery methods, which cover selection, seed handling, germination, planting, and seedling growth. Healthy saplings that can be used as host plants for silkworms are produced through proper nursery management. In this article, the author details the nursery practices of Terminalia bellirica, including seed harvesting, seed pretreatment, germination procedures, seedling management issues, and methods of transplanting. With insight into how to improve these practices, one can increase the survival rate and growth performance of this residential species. Moreover, to ensure *Terminalia bellirica* endures and remains available to future generations, sustainable nursery practices must be embraced to conserve it and provide income to communities who rely on its resources to sustain their lives.

Botanical description of *Terminalia bellerica:*

Habit

Terminalia bellirica (Gaertn.) Roxb, which is also referred to as Bahera or Beleric, is a large Deciduous tree that belongs to the family Combretaceae. It is usually medium to large in size, reaching a height of 25 to 30 meters in natural forests (Bohra *et al*., 2024). The tree has a straight, cylindrical trunk and a spreading, rounded crown. When young, its bark is comparatively smooth, and of a greyish hue; and as it grows, it becomes somewhat rough, of a dark brown color, and cut into deep fissures.

Leaves

Leaves of *Terminalia bellirica* are simple, though they are mostly alternate and concentrated at the tips of the branches, making the tree look dense and leafy. They are irregularly elliptic to rather obovate, and measure 10 to 20 cm. The apex of the leaf is rounded, and the leaf surface is glabrous and glossy with an entire and slightly undulating margin. Its leaves are usually deciduous during the dry season, and the venation is strong. This morphology allows saving water during drought (Akbar, 2020).

Flowers

These have tiny, pale yellow-green flowers borne in axillary spiky-like inflorescences. This is functionally monoecious, with bisexual and male flowers produced on the same tree. The flowering phase generally takes place in April to June. The flowers have little show but secrete nectar, and a variety of pollinators are attracted, especially bees and flies, which cross-pollinate (Shrestha *et al*., 2020).

Fruit and Seed

Fruit is a unique drupe that is ovoid ellipsoid in shape, with a length that ranges between 2-4 cm, and is equipped with five prominent ridges towards its surface.

The fruits are initially green, but during November to February of the year, they turn brown or grey as they mature and ripen. Internally, the fruit contains a hard, stony seed and a tough endocarp. The seeds are physically dormant as a result of an impermeable seed coat, which requires some pre-sowing operation so that the seed has a chance to germinate (Hazra, 2019).

Habitat and Distribution

The range of *Terminalia bellirica* is mostly the Indian subcontinent, Southeast Asia, Queensland, and the Northern Territory in Australia. It grows in moist terrace forests, riverbanks, foothills, and open plains (Zai *et al*., 2024). The species prefers loamy soils that are rich and deep, although it is also tolerant of lateritic, degraded, or moderately saline soils. It can develop at sea level as high as 1000 meters and is very adaptable to tropical and subtropical weather conditions.

Ecological and Economic Significance

Ecologically, the use of *Terminalia bellirica* will be of great value in reforestation and soil conservation, as it has deep roots and the spread of its leaf litter, which adds to soil fertility. The species has several economic uses: traditional Ayurvedic medicine (as a component of the Triphala composition), timber, tannin extraction, and fodder. It is an attractive host plant for the sericulture (forest-based) industry due to the high nutritional and palatability of its leaves for the tasar silkworm (*Antheraea mylitta*). It can be incorporated into the agroforestry system to help conserve biodiversity and support rural livelihoods.

MATERIALS AND METHODS

Study Site Description

The experiment was carried out at the Central Nursery Unit of the Forest College and Research

Institute (FC&RI), Mettupalayam, which is situated at a longitude of 76.56 E and a latitude of 11.18 N, at an altitude of about 300m above mean sea level. The common climatic pattern in this area is subtropical, with a temperature range of 18 °C to 34 °C, and a relative humidity of approximately 65% throughout the research period (May-July, 2024). To maintain a semi-controlled environment and promote uniform seedling growth, the nursery beds were covered with no more than 50 percent shade nets. The control of microclimatic parameters, such as temperature, humidity, and light intensity, which was achieved through monitoring using HOBO micro station data loggers to maintain stability with ICAR nursery management standards.

Seed Collection and Processing

The mature fruits of T. bellirica were harvested in May 2024 at the Tamil Nadu Agricultural University (TNAU) campus; 20 trees bearing fruit in good yield were selected. Trees were chosen based on uniform canopy formation, disease-free, and fruiting performance. Once the collection was complete, the fruits were depulped by hand using wooden paddles. This was fermented for 48 hours after wrapping the fruits in moist gunny bags to help ease the pulp.

After fermentation, the fruits were thoroughly cleaned with running water, and the flotation method was used to remove non-viable seeds. Surface-sterilization was performed on the viable seeds with a 0.5% solution of potassium permanganate ($KMnO_4$) for 5 minutes, followed by three rinses with distilled water. The seeds were sterilized and dried in shade at ambient temperature (28 °C) for 48 hours. The tetrazolium chloride (TZ) method was employed to determine initial viability, which ranged between 82 and 87 percent across the seed lots.

Experimental Design and Layout

The trial was designed using a Completely Randomized Design (CRD) with four pre-sowing treatments and four replications per treatment. Every replication used 15 seeds, so 240 seeds were used during the trial. The seeds were germinated in black polyethylene nursery bags, 25 x 15 cm (200 gauge), into which a sterilized potting mixture was added. To establish, three seeds were sown per bag, and after 20 days, the number was reduced to a single healthy seedling per bag. The layout was designed to introduce random distribution to reduce the impact of micro-environmental variation.

Description of Pre-Treatments

Four seed pre-treatment experiments were conducted: control (untreated), hot water treatment (HWT), overnight (OS), and acid treatment (AT). In the control group, the sown seeds were not treated after undergoing appropriate sterilization. During the hot water treatment, seeds were introduced into water preheated to 80°C and left to stand in it for up to 10 min. The even heat was provided with a precision water bath with magnetic stirring. In the overnight soaking treatment, the seeds were kept in aerated distilled water, and the water was changed after 6, 12, and 18 hours to prevent oxygen depletion and microbial contamination. Seeds were soaked in a 20% sulphuric acid (H_2SO_4) solution, placed under continuous stirring, left in the solution for 15 minutes, and then rinsed thoroughly with running tap water to neutralise any remaining solution before sowing (Bali *et al.*, 2013).

Nursery Establishment and Maintenance

Selection of Nursery Containers and Media Preparation

In case of propagation, the nursery bags used to facilitate easy handling, root development, and ease of handling *Terminalia bellirica* were of black polyethylene (25 × 15 cm, 200-gauge). These pots were filled with a sterilized potting mix of topsoil, coarse river sand, and vermicompost in the ratio of 3:1:1. This mixture has good drainage, is nutrient-rich, and has active microbes. The pH was adjusted to near neutrality, set at about 6.8, which is a favourable point for root establishment and seedling growth.

Seed Sowing Technique and Pre-Treatment Integration

These pre-treated seeds were then sown to a standard depth of 2 cm, and a fine sprinkling of sand was applied over the seeds to aid in aeration and moisture retention.

The seeds were treated using the Hot Water Treatment (80°C in boiling water), Overnight Soaking (24 hours in aerated water), and Acid Treatment (20% sulfuric acid in plain water). These practices were meant to overcome the seeds' physical dormancy, since the seeds were hard. When sowing, three seeds were placed in each bag to ensure establishment, after which they were thinned to leave only one healthy seedling in each container.

Pic 1: Terminalia saplings grown in polybags

Shade Management and Microclimatic Control

In a bid to maximize the germination conditions, 50 shade nets were installed on the nursery site. This arrangement regulated the intensity of light, minimized temperature fluctuations, and protected the seedlings from direct light and high rainfall.

Temperature, humidity, and light intensity are microclimatic parameters that were measured to ensure continuity with the parameters in the ICAR nurseries, using HOBO data loggers. This regulation became critical for uniform, well-timed germination and the development of seedlings. The well-grown plantlets in polybags kept under a shade net are shown in pic 1.

Irrigation Practices

A drip irrigation system was used to irrigate the plants, and the system was calibrated to maintain soil moisture at about 80 percent of field capacity. This system reduced water wastage and ensured a regular supply of moisture, and there was no waterlogging. To accurately monitor soil moisture, soil moisture probes were used, and the level adjusted based on weather and the needs of the seedlings daily. Regular and scheduled irrigation was critical to avoiding both under- and over-water stress during the seedling's progressive development (Mohammad *et al*., 2021).

Biofertilizer Application

To promote early root growth and improve nutrient absorption, the potting media was incorporated with biofertilizers, including Azospirillum and phosphate-solubilizing bacteria (PSB), at a rate of 2 kg/m^3. These microbial inoculants enhanced the availability of nitrogen fixation and phosphorus solubilization, thereby improving the nutritional content of the growing medium in a natural manner. They used during sowing helped produce healthier, more robust seedlings with better shoot and root development.

Pest and Disease Management

An Integrated Pest Management (IPM) program was implemented to protect seedlings from biotic stress. A neem oil botanical pesticide at 5 ml/L was used as a control for common insect pests through weekly foliar applications. To keep the population of flying insects under control and keep an eye on them, yellow sticky traps were placed. Also, Trichoderma viride, a beneficial fungus, was added to the growing media to control soil-borne pathogens. This integrative model reduced the use of chemical pesticides and enhanced a healthy nursery ecology (Khin Mar Myint *et al*., 2006).

Seedling Thinning and Maintenance

This was done by thinning at 20 days after planting, leaving only one healthy seedling per bag. This guaranteed a maximum space and nutrient supply for particular plants. Regular weeding and loosening of the soil surface to enable air infiltration and monitoring for nutrient deficiencies or pest attacks were regularly done. Isolating the individual plants reduced variation in plant health and minimized intraspecific competition, thereby increasing uniformity and survival in the nursery.

Observation and Data Recording

The germination of the seed was observed at 15, 20, 30, and 45 days after sowing (DAS). Germination was observed when the radicle length exceeded 2 mm.

Following thinning, seedling height and root length were measured every 15 days until 60 DAS. The vigor of the seedlings was determined after 14 days as the seedling vigor index (SVI), calculated as the product of two parameters: germination percentage and average seedling length. A millimeter ruler and the shoot measured the length of the shoot and the length of the root: root ratio was computed to determine the balance of the seedling. Statistical analysis procedures were used to assess the effects of various treatments on germination and early growth.

RESULTS

Germination Response

There were considerable variations in the germination percentage of seeds of *Terminalia bellirica* as a result of the four pre-sowing treatments. The seeds exposed to Hot Water Treatment (HWT) had the highest germination of 68.2 percent after 45 days of planting (DAS). The figures for final germination were 56.3 percent and 50.1 percent for overnight soaking (OS) and Acid Treatment (AT), respectively. Conversely, the lowest germination was observed in untreated seeds (control), with 20.0 percent germination recorded at 45 DAS. The trend implies that dormancy-breaking pre-treatments, especially thermal and hydropriming, are crucial for enhancing seed germination of this recalcitrant species with hard-coated seeds.

Seed Viability Prior to Sowing

The viability test using tetrazolium chloride (TZ) conducted prior to administering the treatments indicated that all seed lots had high viability, with values between 83.7 and 86.3 percent. This affirmed that the differences in germination were more due to the treatments than to the particular quality of the seeds. The initial viability was highest in After Soaking (86.3 %), HWT (85.1 %), untreated and acid-treated seeds (84.2 and 83.7 %, respectively).

Germination Speed and Uniformity

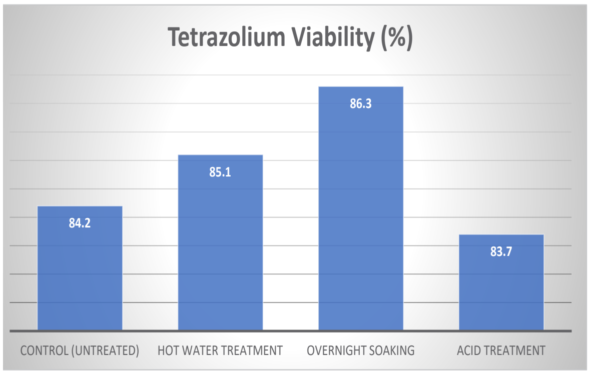
The Hot Water Treatment had a major impact on the number of days to first germination, which was as low as 12.3 days, whereas in the untreated control, the number of days to the initiation of emergence was 21.5 days. Average emergence was 14.8 and 16.2 days in OS and AT, respectively. Accelerated and better-coordinated germination in HWT and OS indicates an improved rate of metabolic activation and greater efficiency of water absorption during imbibition.

Table 1: Germination percentage of *Terminalia bellirica* seeds under different pre-sowing treatments

Treatments	Date of Treatment	Date of Sowing	Germination Percentage			
			15th Day	20th day	30th day	45th day
Control (Untreated)	15-May-2024	16-May-2024	8.0% ± 1.5%	12.5 ± 1.8%	18.3 ± 2.1%	20.0 ± 2.4%
Hot Water Treatment (HWT)	15-May-2024	16-May-2024	30.0% ± 2.5%	42.6 ± 3.2%	64.7 ± 3.5%	68.2 ± 3.8%
Overnight Soaking (OS)	15-May-2024	16-May-2024	25.0% ± 2.2%	35.4 ± 2.9%	52.8 ± 2.8%	56.3 ± 3.1%
Acid Treatment	15-May-2024	16-May-2024	18.0% ± 2.0%	28.7 ± 2.5%	45.2 ± 3.0%	50.1 ± 3.2%

Table 2: Seed Viability Percentage Before Treatment of *Terminalia bellirica* Seeds under Different Pre-Sowing Treatments

Treatment Type	Tetrazolium Viability (%)	Standard Deviation
Control (Untreated)	84.2	±1.4
Hot Water Treatment	85.1	±1.2
Overnight Soaking	86.3	±1.3
Acid Treatment	83.7	±1.6



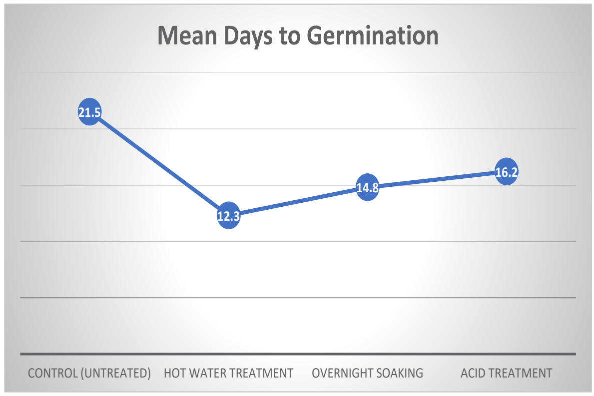


Table 3: Mean Days to First Germination (MTFG) of Terminalia bellirica seeds under different pre-sowing treatments

Treatment	Mean Days to Germination	Standard Deviation
Control (Untreated)	21.5	±1.1
Hot Water Treatment	12.3	±0.9
Overnight Soaking	14.8	±1.0
Acid Treatment	16.2	±1.3

Seedling Height Growth

Seedling height increased progressively from 15 DAS to 60 DAS, and there were also marked differences among the treatments. A significant difference in mean height was observed among HWT, OS, and AT seedlings, with average heights of 13.1 cm, 11.7 cm, and 9.8 cm, respectively, at 60 DAS, compared to control seeds, which had a height of 6.9 cm. Increased shoot elongation in the HWT and OS is a sign of enhanced seedling vigor and nutrient mobilization at the early point of development.

Root Length and Shoot: Root Ratio

The development of the root followed a similar course to that of shoot growth. The root length of the HWT-treated seedlings was the highest (7.6 cm), indicating enhanced growth in the underground, which is crucial for the absorption of water and nutrients. The treatment effects exerted by the OS and AT resulted in roots measuring 6.5 cm and 5.9 cm, respectively, whereas roots of control seedlings grew to only 4.1 cm. A shoot: root ratio of 1.66 (acid) to 1.80 (OS) was obtained, and the balanced growth pattern obtained was 1.72 for HWT, making it adhere to the growth traits of both aerial and root biomass.

Seedling Vigor Index (SVI)

The SVI, as a composite parameter that measures

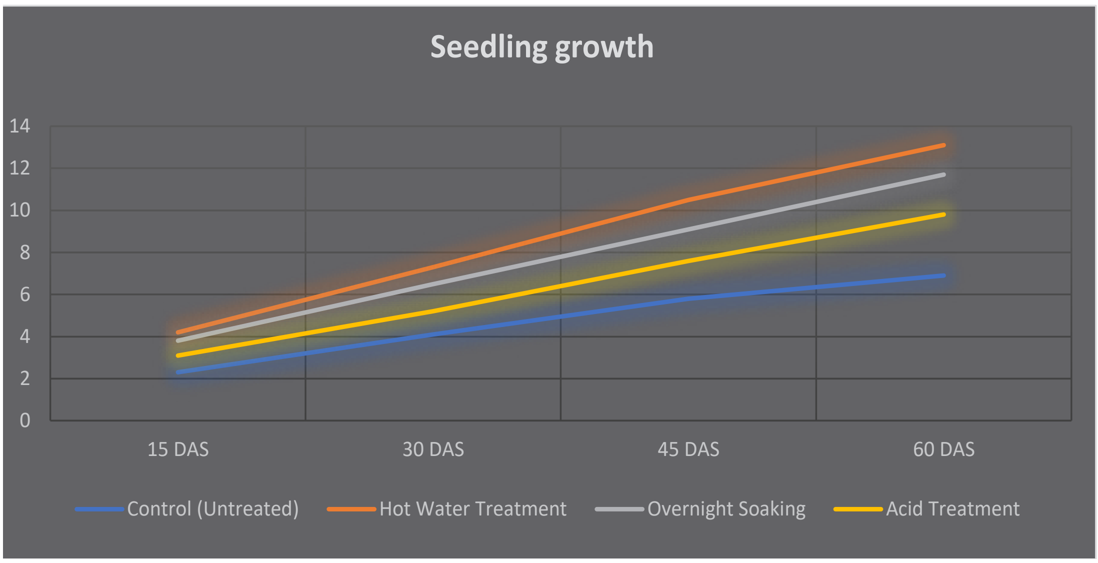
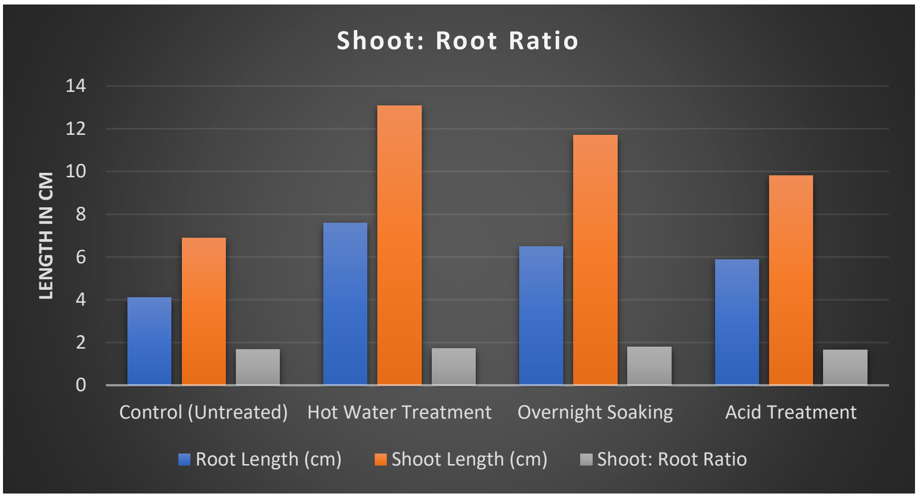


Table 4: Seedling Height (cm) at Different Intervals of Terminalia bellirica Seeds under Different Pre-Sowing Treatments

Treatment	15 DAS	30 DAS	45 DAS	60 DAS
Control (Untreated)	2.3	4.1	5.8	6.9
Hot Water Treatment	4.2	7.3	10.5	13.1
Overnight Soaking	3.8	6.5	9.1	11.7
Acid Treatment	3.1	5.2	7.6	9.8

Table 5: Root Length and Shoot: Root Ratio (at 60 DAS) of *Terminalia bellirica* seeds under different pre-sowing treatments

Treatment	Root Length (cm)	Shoot Length (cm)	Shoot: Root Ratio
Control (Untreated)	4.1	6.9	1.68
Hot Water Treatment	7.6	13.1	1.72
Overnight Soaking	6.5	11.7	1.80
Acid Treatment	5.9	9.8	1.66



seedling health and strength, was found to be significantly affected by the treatments. HWT had the highest SVI (893.4), followed by OS (659.7), AT (491.0), and control (138.0). This is evidence of the overall impact of a combination of thermal and hydration-based pre-treatments on seedling performance.

DISCUSSION

The current paper explicitly shows that the nature of the pre-sowing treatment applied in the experiment significantly affects germination and early seedling growth of *Terminalia bellirica*. Hot Water Treatment (HWT) had been more effective than other treatments in most cases regarding germination percentage, emergence, seedling tallness, and vigor index. This is because it effectively reduces the strength of the hard seed coat and allows water absorption, which plays a decisive role in germination in dormant species such as T. bellirica.

Table 6: Seedling Vigor Index (SVI) of *Terminalia bellirica* seeds under different pre-sowing treatments

Treatment	Germination % (45 DAS)	Seedling Length (cm)	Vigor Index
Control (Untreated)	20.0	6.9	138.0
Hot Water Treatment	68.2	13.1	893.4
Overnight Soaking	56.3	11.7	659.7
Acid Treatment	50.1	9.8	491.0

Overnight Soaking (OS) also showed to be encouraging, as it promotes the activation of enzyme processes involved in germination through hydration. OS is a down-to-earth, farmer-friendly method, despite being regarded as a bit less effective than HWT, it may readily be applied in decentralized nursery systems.

There was mild success in germination with Acid Treatment, and greater variability in growth parameters, perhaps due to the risk of overexposure or seed Coat damage. Control seeds performed at an impoverished level across all expected parameters, further substantiating the necessity of the dormancy-breaking intervention.

The high degree of association between germination percentage and seedling vigor index underscores the importance of pre-treatments in not only improving emergence but also producing healthier, more vigorous seedlings. Such results concur with those previously reported in other Terminal species and on tropical tree crops, where pre-treatments had a great impact on seedling growth and transplant success. Also, the shoot: root ratio determined in seedlings following the treatment reflects enhanced physiological acclimatization, a key factor for survival in the semi-arid or forest-edge ecosystems characteristic of sericulture plantation agriculture.

CONCLUSION

According to the findings of the research paper, pre-sowing treatments are crucial to improving the performance of the *Terminalia bellirica* nursery. Hot Water is best at increasing the speed, percentage, and vigor of germination when compared to the other two methods tested, i.e.

Overnight soaking followed by Hot Water Treatment. The techniques not only enhanced the overall quality of seedlings but also improved the efficiency of resource utilization and the output of the nurseries. Such optimized nursery actions are very helpful in afforestation schemes, biodiversity CHP, and sericulture-based agroforestry. T. bellirica is a successful propagation that can be used to improve the livelihoods of people living in rural areas and to have ecological importance of such areas that have been degraded, as it can act as a host plant to silkworms that can sustain itself.

Recommendations

- Hot Water Treatment (80 °C, 10 min) should be recommended as a pre-treatment regime standard in propagating T. bellirica seeds by Nursery Managers.
- Nurseries at the farm level with insufficient infrastructure can use the Overnight Soaking as a cheaper and effective alternative.
- Future Research before and after the Reprint of this Article should also apply combinations of thermal, mechanical scarification and bio-priming treatments to increase further the uniformity of germination and early seedling growth.
- Long-Term Field Trials are suggested to test the survival rate and growth performance of treated seedlings in the practical environment of silkworm agroforestry systems.
- Awareness Program and training of the sericulture farmers and forestry extension officers on better nursery practices on *Terminalia bellirica* should be carried out.

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Conflict of Interests and Declarations

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Ethics Statement

This study involved plant-based experimental material and did not involve human participants or animals. Therefore, ethical approval from an institutional ethics committee was not required.

Originality and Plagiarism

The authors affirm that this manuscript is an original work and has not been published previously nor is it currently under consideration for publication elsewhere. All sources of information and previously published materials used in this manuscript have been appropriately cited and acknowledged. The manuscript has been prepared in accordance with accepted academic standards to avoid plagiarism.

Consent for Publication

All authors have read and approved the final version of the manuscript and consent to its submission and publication in the journal.

Competing Interests

The authors declare that they have no competing financial or non-financial interests that could have influenced the research, analysis, or interpretation of the results presented in this manuscript.

Data Availability

All data generated or analyzed during this study are included within the manuscript. Additional information related to the study can be obtained from the corresponding author upon reasonable request.

Author Contributions

All authors contributed significantly to the research and preparation of this manuscript. Conceptualization and study design were carried out by the lead author. Experimental work and data collection were performed by the research team. Data analysis and interpretation were conducted collaboratively. The manuscript was drafted by the lead author and critically reviewed, edited, and approved by all co-authors prior to submission.

REFERENCE:

Akbar, S. (2020). Terminalia bellirica (Gaertn.) Roxb. (Combretaceae) (Syns.: T. angustifolia Blanco, nonJacq.; T. attenuata Edgew.; T. edulis Blanco; T. moluccana Roxb.; T. punctata Roth; Myrobalanus bellirica Gart.; M. laurinoides (Teijsm. & Binn.) Kuntze). In *Handbook of 200 Medicinal Plants: A Comprehensive Review of Their Traditional Medical Uses and Scientific Justifications* (pp. 1771-1777). Cham: Springer International Publishing.

Bali, R. S., Chauhan, D. S., & Todaria, N. P. (2013). Effect of growing media, nursery beds and containers on seed germination and seedling establishment of Terminalia bellirica(Gaertn.) Roxb., a multipurpose tree. *Tropical Ecology*, *54*(1), 59-66. https://www.cabidigitallibrary.org/doi/full/10.5555/20133125796

Bohra, N. K., Manda, M., Jat, R., & Dudi, H. (2024). Effect of Seed size and pre-sowing treatment on seed germination of Terminalia bellirica. DOI:10.46431/MEJAST.2024.7301

Hazra, K. (2019). Phytochemical investigation of Terminalia bellirica fruit inside. *Asian J Pharm Clin Res*, *12*(8), 191-194. DOI:10.22159/ajpcr.2019.v12i8.34347

Khin Mar Myint, K. M. M., Myint Thaung, M. T., & Tun Tun Lin, T. T. L. (2006). Natural incidence, biological study, and control of some insect pests in Terminalia belerica. https://www.cabidigitallibrary.org/doi/full/10.5555/20143398176

Mohammad, N., Rajkumar, M., Singh, K., Nain, N. P. S., Singh, S., Rao, G. R., & Prakasham, U. (2021). Spacing, pit size and irrigation influence early growth performances of forest tree species. *Journal of Tropical Forest Science*, *33*(1), 69-76. DOI:10.26525/jtfs2021.33.1.69

Ramesh, M., Umate, P., Venugopal Rao, K., & Sadanandam, A. (2005). Micropropagation of Terminalia bellirica Roxb.—a sericulture and medicinal plant. *In Vitro Cellular & Developmental Biology-Plant*, *41*(3), 320-323. https://doi.org/10.1079/IVP2004626.

Shrestha, R., Acharya, R. P., Bussmann, R. W., & Paniagua-Zambrana, N. Y. (2020). Terminalia bellirica (Gaertn.) Roxb. Terminalia chebula Retz. Combretaceae. In *Ethnobotany of the Himalayas* (pp. 1-10). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-45597-2_244-1

Zai, M. J. Y., Cheesman, M. J., & Cock, I. E. (2024). A Review of the ethnobotany, phytochemistry and medicinal properties of Australian Terminalia species. *Pharmacognosy Communications*. DOI:10.5530/pc.2024.1.3