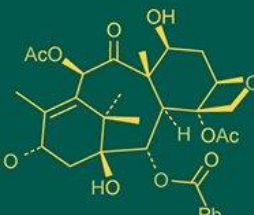
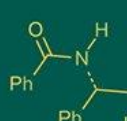


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Influence of pre-sowing treatments on seed quality parameters in *Elaeocarpus floribundus*.

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Abstract

Pre-sowing treatment for *Elaeocarpus floribundus* was conducted at College of Forestry, Ponnampet. Six pre-sowing techniques were applied to seeds collected from mature, healthy trees in the sacred forest (Devarakadu) near Ponnampet. Sand and top soil were mixed in a 1:1 ratio in plastic trays for the germination test. ANOVA results revealed no discernible variations between the various pre-sowing treatments. The germination process was impacted by the pre-sowing technique and the seeds soaked in H₂O₂ 4% for 24 hours followed by water for 24 hours, GA₃ 350 ppm for 24 hours and control showed the highest seed quality metrics. However, seeds treated with 4% H₂SO₄ for 24 hours and soaked in boiling water for 2 minutes, as well as seeds treated with normal water for 24 hours and soaked in boiling water for 2 minutes, did not sprout. While seeds from the same lot did not germinate when placed in a nursery without pre-sowing treatment, they did exhibit germination in a laboratory. Hence, seed treatment with H₂O₂ 4% for 24 hours can be suggested for pre-sowing treatment of *Elaeocarpus floribundus*.

Keywords: *Elaeocarpus floribundus*, Pre-sowing treatments, Seed quality

Introduction

The olive species, *Elaeocarpus floribundus* (*E. floribundus*) (family: Elaeocarpaceae), is an evergreen tree of modest stature with a wide crown and a clean trunk ranging from 12 to 16 meters, celebrated for its fruit and recognized as a valuable medicinal plant native to India. *Elaeocarpus floribundus* exhibits significant therapeutic potential, with various plant parts—including the leaves, fruit, bark and roots—traditionally utilized in disease management. The species demonstrates notable biological activities, particularly antioxidant and antibacterial properties, which are attributed to a rich profile of bioactive phytochemicals, predominantly phenolic compounds. Morphologically, the fruit contains a hard, three-celled stone housing spindle-shaped seeds that exhibit recalcitrant behavior despite their rigid endocarp. *E. floribundus* typically thrives on hill slopes and ridges across sandy-to-clay soil compositions. Commercially, the edible fruits of the Indian olive (*Elaeocarpus floribundus*) are primarily processed into pickles, while its timber serves as a suitable raw material for light interior construction, plywood, particle board, fiberboard and paper pulp production. The species is primarily propagated via seeds; however, cultivation is significantly hindered by extended seed dormancy, which results in low germination rates and delayed seedling development.

Species within the genus *Elaeocarpus* are predominantly evergreen trees or shrubs, though a minority exhibit briefly deciduous, epiphytic, or lianescent growth habits. Leaves are simple (strictly unifoliate) and arranged alternately, featuring prominent venation, frequently serrated margins and a distinct pulvinus at the petiole base, characteristically turning red prior to abscission. The inflorescences are typically racemose, bearing mostly bisexual flowers with 4–5 sepals and petals, alongside numerous stamens; the petals are notably distinguished by finely divided, linear lobes. The resulting fruit is a spherical-to-oval drupe, typically blue or black in color, enclosing a characteristically sculptured endocarp.

Given the paucity of data regarding seed biology in *Elaeocarpus floribundus*, this study investigates the efficacy of various pre-sowing treatments on the species' seeds. Although seeds represent the primary natural mechanism for plant reproduction, genetic conservation, transport and species propagation, viable seeds frequently fail to germinate under optimal environmental conditions due to seed dormancy^[5]. This physiological inhibition is

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governed by internal mechanisms—such as seed coat impermeability, embryo immaturity, or endogenous biochemical inhibitors—which directly restrict germination rates [7]. Overcoming these physiological barriers requires species- and lot-specific pre-treatment protocols tailored to the precise mechanism of dormancy involved.

Seed dormancy presents a primary barrier to successful germination, which can be mitigated through targeted pre-sowing treatments tailored to the specific dormancy mechanism of the seed. Standard methods include mechanical or acid scarification, hot or cold water soaking, chemical application, plant growth regulators, and alternate wetting and drying cycles. Recent technological advancements have expanded traditional seed processing to include innovative techniques such as seed priming, gamma irradiation, and magnetic field exposure to enhance germination rates. Furthermore, nanotechnology has

emerged as a promising frontier in accelerating seed germination. Given that a key bottleneck in mass propagation and species conservation is the lack of standardized protocols for many tree species, this review highlights both traditional and advanced seed pre-treatment methodologies along with their functional significance.

Material and Methods

Study site and growing media: The present study was carried out during 2023 in laboratory of Department of Forest Biology and Tree improvement, College of Forestry, Ponnampet, Kodagu district of India. Mature seeds of *Elaeocarpus floribundus* were harvested from a sacred grove (*Devarakadu*) located near Ponnampet which lies between 12° 11' 60" N latitude and 75° 33' 36" E, elevation of 867 above MSL. To minimize non-treatment variation, uniform-sized seeds were selected for the study.

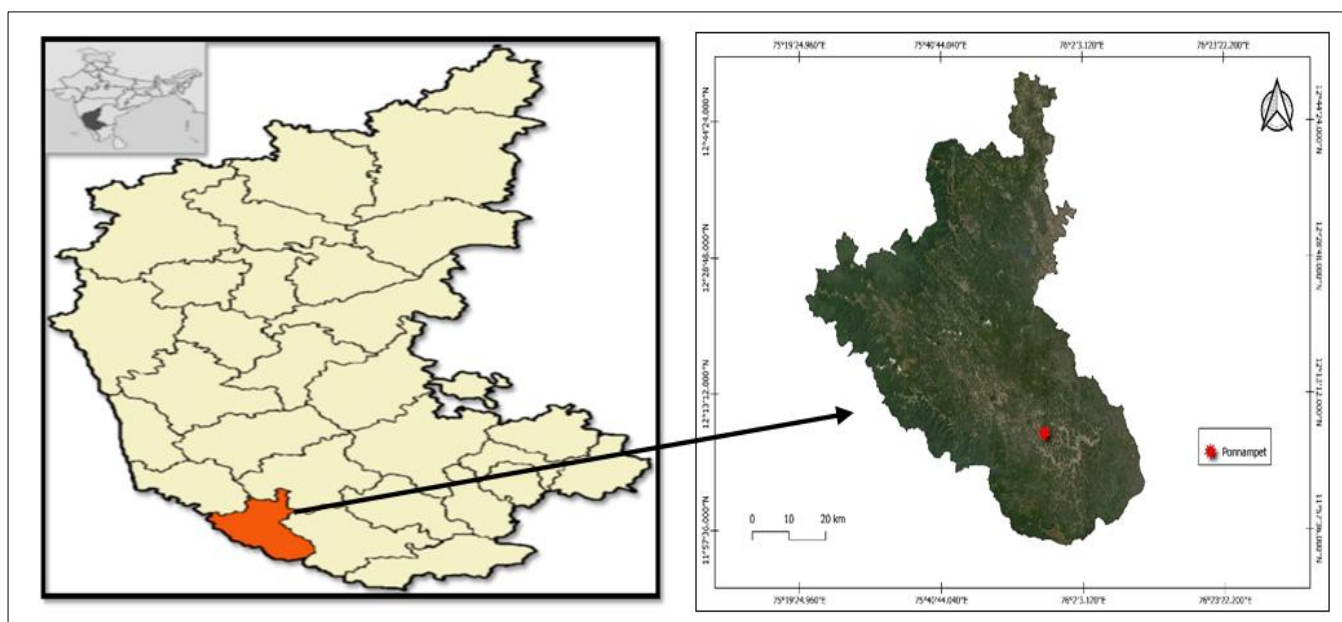


Fig 1: Study area map

Experimental design and treatment combinations: The pre-sowing treatment experiments for *Elaeocarpus floribundus* were carried out at the College of Forestry, Ponnampet. Germination assays were conducted in polythene trays using a 1:1 (v/v) sand and topsoil substrate. The study followed a Completely Randomized Design (CRD) comprising six treatments, including a control, with four replications per treatment. Each replication utilized 100 seeds to systematically evaluate the influence of the pre-sowing treatments on germination performance. The pre-sowing experiment comprised six distinct treatment protocols. In T_0 (control), seeds received no chemical or physical treatment. In T_1 , seeds were soaked in a 4% sulfuric acid (H_2SO_4) solution for 24 hours. Seeds in T_2 were immersed in boiling water for 2 minutes followed by a 24-hour soak in ambient-temperature water. T_3 involved soaking seeds in ambient-temperature water for 24 hours. For T_4 , seeds were immersed in a 4% hydrogen peroxide (H_2O_2) solution for 24 hours. In T_5 , seeds were subjected to boiling water immersion for 2 minutes only. For T_6 , seeds were soaked in a 350ppm gibberellic acid (GA_3) solution for 24 hours. Following their respective pre-treatments, seeds across all groups were sown in a sand medium for

germination evaluation. The experimental treatment details are summarized below:

- T_0 : Control
- T_1 : H_2SO_4 4% for 24 hrs
- T_2 : Soaking in boiling water for 2 min and then in normal water for 24 hrs
- T_3 : Soaking in water for 24 hrs
- T_4 : H_2O_2 4% for 24 hrs
- T_5 : Soaking in boiling water for 2 min
- T_6 : GA_3 350ppm for 24 hrs

Germination percentage

Pre-treated seeds were placed in a seed germinator maintained at 30°C and 90% relative humidity. The count of normal seedlings was recorded on the 30th day post-sowing under controlled laboratory conditions. Germination percentage was subsequently calculated using the following equation:

$$\text{Germination (\%)} = \frac{\text{Number of normal seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Shoot length

Ten normal seedlings were randomly selected from each of the four replications per treatment. Shoot length was measured using a standard graduated scale and the mean shoot length was computed and expressed in centimeters (cm).

Root length

At the time of the final germination count, ten normal seedlings were randomly sampled from each of the four replications per treatment. Root length was measured using a standard graduated scale and the mean root length was calculated and expressed in centimeters (cm).

Seedling dry weight

Seedling dry weight was evaluated following the final germination count on day 30. Seedlings were dried in a hot air oven, after which the dried biomass for each replication was weighed to determine the mean seedling dry weight, expressed in grams.

Vigour Indices

Seed vigour reflects the total properties that determine the potential for rapid, uniform emergence and robust seedling development under diverse environmental conditions. The seed vigour index was calculated according to the formula proposed by Abdul-Baki and Anderson (1973) and expressed as a whole number.

Vigour Index-I

It was calculated by using following formula:

Standard germination (%) × Average seedling length (cm)

Vigour index-II

It was calculated by using following formula:

Standard germination (%) × Average seedling dry weight (g)

Statistical Analysis: Data were subjected to statistical analysis to assess treatment variations using Microsoft Excel

and AGRISTAT software. Analysis of Variance (ANOVA) was performed in accordance with the experimental design, following the methodology described by Panse and Sukhatme (1967) ^[13].

Results and Discussion:

Germination period: Seed germination initiated on day 22 post-sowing and extended through day 34. Pre-sowing treatments significantly influenced the germination timeframe. The shortest imbibition period to germination onset (22 days) was recorded in treatments T₃, T₄, T₅, and T₆, whereas the control group (T₀) exhibited significantly delayed germination, requiring the longest imbibition period of 26 days (Table 1).

Germination percentage: The perusal of results presented reveals that germination was significantly affected by all the treatments except control, soaking in water for 24 hours, soaking in H₂O₂ 4% for 24 hours and soaking in GA₃ 350ppm for 24 hours. The highest germination percentage was recorded in seeds treated with 4% H₂O₂ for 24 hours, followed by those soaked in water for 24 hours. Conversely, complete germination failure occurred in seeds exposed to 4% concentrated H₂SO₄, boiling water for 2 minutes, and boiling water (2 minutes) combined with a 24-hour water soak. The detrimental effect of H₂SO₄ likely stems from acid penetration through the exposed micropyle, which damages internal embryonic tissues (Ells, 1963) ^[5]. The enhanced germination observed under 4% H₂O₂, 24-hour water soaking, and 350 ppm GA₃ can be attributed to seed coat softening, scarification and increased coat permeability. Structural modifications to the seed coat facilitate water imbibition into the embryo and cotyledons, thereby promoting radicle emergence.

Germination value and germination energy: Germination values varied significantly across treatments, ranging from 0.6 to 1.9. The highest germination value was recorded in treatment T₄ (1.9), followed by T₃ and T₆ (both 1.2), while the lowest was observed in the control group (T₀, 0.6). Similarly, germination energy peaked in T₃ (25%), followed by T₆ (23.25%) and was lowest in T₀ (13.75%) (Table 1).

Table 1: Imbibition period, germination period, germination percentage, germination value and germination energy of *Elaeocarpus floribundus* seeds under different pre-sowing treatments.

Treatment	Imbibition period (day)	Total germination period (day)	Germination (%)	Germination Value	Germination Energy (%)
T ₀ : Control	26	34	13.33	0.6	13.75
T ₁ : H ₂ SO ₄ 4% for 24 Hrs	22	0	0.00	0	0
T ₂ : Soaking in boiling water for 2 min and then in normal water for 24 Hrs	24	0	0.00	0	0
T ₃ : Soaking in water for 24 Hrs	22	32	46.67	1.2	25.00
T ₄ : Soaking in H ₂ O ₂ 4% for 24 Hrs	22	32	50.00	1.9	17.75
T ₅ : Soaking in boiling water for 2 min	22	0	0.00	0	0
T ₆ : Soaking in GA ₃ 350ppm for 24 Hrs	22	34	26.67	1.2	23.25
Sem ±	0.47	0.14	6.15	0.42	0.13
CD @ 1 %	1.9	0.59	12.08	1.72	0.54

Table 2: Effect of pre-sowing treatments on shoot and root length seedling length, seedling dry weight, SV I and SV II of *Elaeocarpus floribundus*.

Treatment	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seedling dry weight (g)	Seedling vigour index I	Seedling vigour index II
T ₀ : Control	5.6	1.3	6.9	0.12	92.1	1.60
T ₁ : H ₂ SO ₄ 4% for 24 Hrs	0	0	0	0	0	0
T ₂ : Soaking in boiling water for 2 min and then in normal water for 24 Hrs	0	0	0	0	0	0
T ₃ : Soaking in water for 24 Hrs	7.6	1.3	8.9	0.12	406.2	5.83
T ₄ : Soaking in H ₂ O ₂ 4% for 24 Hrs	8.1	2.0	10.1	0.13	505.43	6.60
T ₅ : Soaking in boiling water for 2 min	0	0	0	0	0	0
T ₆ : Soaking in GA ₃ 350ppm for 24 Hrs	7.3	1.4	8.8	0.12	235.23	3.29
Sem ±	0.80	0.17	0.96	0.01	57.84	0.79
CD @ 1 %	0.21	0.09	0.23	0.004	179.36	2.50

Shoot and root length (cm)

Maximum shoot and root lengths (8.1 cm and 2.0 cm, respectively) were recorded in seeds treated with 4% hydrogen peroxide for 24 hours (T₄), which performed significantly better than all other treatments (Table 2). This was closely followed by water soaking for 24 hours (T₃; 7.6 cm shoot / 1.3 cm root) and 350 ppm GA₃ for 24 hours (T₆; 7.3 cm shoot / 1.4 cm root). The superior performance under H₂O₂ and GA₃ treatments may be attributed to enhanced nutrient availability and the physiological activity of endogenous growth promoters during early seedling development. These findings align with those of Krishna *et al.* (2011) [9] and Ajay *et al.* (2022), who observed that pre-sowing organic and growth regulator treatments significantly enhanced seedling vigor, shoot height and biomass accumulation in hard-coated seed species like *Melia dubia*.

Seedling dry weight (g)

The information (Table 2) demonstrated that various pre-sowing treatments on seed had a substantial impact on the dry weight of *Elaeocarpus floribundus* seedlings. The highest seedling dry weight (0.13 g/10 seedling) was recorded in seeds treated with 4% hydrogen peroxide for 24 hours (T₄), performing significantly higher than all other treatments. This was followed by 24-hour water soaking (T₃) and 350 ppm GA₃ for 24 hours (T₆), both yielding 0.12 g/10 seedlings.

Seedling Vigour Index-I and Vigour Index-II

The Vigour Index-I of *Elaeocarpus floribundus* seedlings was strongly impacted by several pre-sowing treatments, (Table 2). The highest Vigour Index I (505.43) was recorded in seeds treated with 4% hydrogen peroxide for 24 hours (T₄), which was significantly superior to all other treatments. This was followed by seeds soaked in water for 24 hours (T₃; 406.2), 350 ppm GA₃ for 24 hours (T₆; 235.23) and the untreated control (T₀; 92.1).

A similar trend was observed for Vigour Index II in *Elaeocarpus floribundus* across the pre-sowing treatments. Treatment T₄ (4% H₂O₂ for 24 hours) recorded the highest Vigour Index II (6.60), significantly outperforming all other treatments. This was followed by 24-hour water soaking (T₃; 5.83), 350 ppm GA₃ for 24 hours (T₆; 3.29) and the untreated control (T₀; 1.60).

Discussion:

Pre-sowing treatments are widely recognized for their capacity to enhance seed germination parameters (Hossain, 2005). The natural germinability of *Elaeocarpus floribundus* seeds is typically low (<50%), with hydrogen peroxide

soaking often proving to be the most effective treatment for breaking dormancy (Halder *et al.*, 2023) [6]. Consistent with these observations, the present study demonstrates that soaking *E. floribundus* seeds in 4% H₂O₂ for 24 hours substantially increased germination speed, final germination percentage, seedling growth, and biomass production relative to the control. These results closely mirror the findings of Halder *et al.* (2023) [6], who reported peak germination in *E. floribundus* using 5% H₂O₂, as well as Niamjit Das (2014) [12], who noted enhanced germination following acid scarification with H₂SO₄.

Conclusion

Exploring potential indigenous flora as alternative industrial raw materials directly supports their conservation by preserving genetic diversity and safeguarding native species against endangerment, thereby enhancing regional ecological sustainability. Standardization of mass propagation protocols for native species like *Elaeocarpus floribundus* represents a crucial initial step toward sustainable laboratory and commercial production. Ultimately, this study demonstrates that pre-sowing seed treatments are a key determining factor in significantly increasing the germination percentage and early seedling performance of *E. floribundus*.

Even though seed propagation is simpler, we might not always have an abundance of seeds (Hussain *et al.*, 2018) [7]. The second biggest obstacle to seed germination is its viability, which indicates the extent to which a seed is alive, metabolically active and possesses enzymes that can catalyze the metabolic reactions required for germination. Seed viability is likely at its peak during physiological maturity, after which it gradually decreases (Copeland & McDonald, 2012) [4]. Additionally, some seeds display seed dormancy, which is one of the major obstacle to seed germination. A physiological state known as "seed dormancy" occurs when a fertile seed fails to germinate even under ideal circumstances. It prevents an intact, viable seed from fully germinating.

Based on the pre-sowing seed treatment evaluation in *Elaeocarpus floribundus*, it can be concluded that a 24-hour soak in 4% hydrogen peroxide (H₂O₂) yields superior germination performance under laboratory conditions. Furthermore, key seedling growth metrics—including shoot length, root length, dry weight, and vigour indices—were significantly maximized by this treatment. Consequently, pre-treating seeds with 4% H₂O₂ for 24 hours is recommended for nursery managers and growers to enhance the germination efficiency and early growth performance of *E. floribundus*.

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