

Effect of Treatments on Seed Germination of *Ricinodendron heudelotii* (Euphorbiaceae) in a Nursery in Soubré (South-West Côte d'Ivoire)

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Abstract

Ricinodendron heudelotii, commonly known as Apki in Côte d'Ivoire, is a multi-purpose tree. However, threatened by climatic variations and anthropogenic activities, in particular the extension of agriculture and the high human consumption of its seeds, the species has difficulties in natural regeneration due to the integumentary resistance of the seeds. The objective of the study is to contribute to the improvement of the germination potential of *Ricinodendron heudelotii* in nurseries with a view to sustainable agroforestry and thus its domestication. During this study, carried out in the department of Soubré, Apki seeds were tested by 14 treatments, including the control treatment, before sowing. They are grouped into 5 processes, namely: mechanical (scarification), chemical (soaking with sulphuric acid for various periods of time), immersion in water for various durations, hormonal (soaking with gibberellin in different concentrations), and thermal (soaking in boiling water). The results showed that seed treatments by scarification (T₁), soaking in tap water for 7 days (T₁₂), and soaking with sulphuric acid for 12 minutes (T₁₀) gave the best germination rates with 51.66%, 43.33%, and 30% respectively, within a short delay of 10 to 13 days, during a maximum germination period of 11 days. This study contributes to the acquisition of Apki seedlings at a reduced cost and in a better timeframe for their integration into agroforestry for sustainable conservation. Thus, without costs and being less laborious, with a germination rate of 43.33%, the method of soaking in water for 7 days is recommended for farmers for the production of seedlings of the species for its domestication, unlike scarification which is labor-intensive and presents risks of seed destruction.

Keywords

Ricinodendron heudelotii, Seed Treatments and Germination, Sustainable Conservation, Soubré in Southwestern Côte d'Ivoire

1. Introduction

Plants constitute indispensable natural resources for human nutrition and healthcare [1]. However, numerous plant species have disappeared or become rare, primarily during the last century, due to human activities such as logging, agricultural expansion, and urbanization in Africa [2]. In Côte d'Ivoire, the degradation of forest cover has been rapid and excessive; approximately 12 out of 16 million hectares disappeared between 1960 and 1990, leading to the rarefaction and disappearance of several food and medicinal species [2].

Biodiversity in general is threatened by anthropogenic pressures, notably agricultural expansion and urbanization, among others; with the loss of plant species with non-timber forest products such as *Thaumatococcus daniellii* (Benn.) Benth. & Hook. F. (Marantaceae), liana palms (rattans): *Eremospatha hookeri* G. Mann and H. Wendl (Arecaceae); and fruits of certain species such as *Tieghemella heckelii* (A. Chev.) Pierre ex Dubard, *Irvingia gabonensis* Aubry Lecomte, and *Ricinodendron heudelotii* (Baill.) Pierre ex Heckel.

Ricinodendron heudelotii is a morphologically large tree and a mesophanerophyte biologically, with a height reaching 30 meters. The species is well-known for its seeds, which are widely used for their organoleptic qualities. Its almonds, highly appreciated in sauces as a flavor and thickening agent in both rural and urban areas, are the subject of lucrative trade held exclusively by women in West and Central African markets, and are also exported to the West due to their high nutritional value [3]. Furthermore, studies have already been conducted on the germination constraints of the species [2]. In most countries, more and more land is used for agriculture than for any other human activity. Agriculture represents between 28% and 40% of total land use worldwide [4]. Due to the extent of the land involved, agricultural development represents a growing threat to global biodiversity and one of the main causes of habitat destruction and the range of plant species, including *Ricinodendron heudelotii*, commonly known as Apki in Côte d'Ivoire.

The species *Ricinodendron heudelotii* is subject to multiple uses, which, however, constitute a threat to its sustainable conservation. Its natural regeneration and seed coat dormancy are major constraints to its domestication [5], in addition to anthropogenic factors [6].

According to [7], the domestication of *R. heudelotii* faces various biological hazards, including the difficulty of seed germination and phytosanitary constraints.

Faced with this observation, it is necessary to find processes and optimal con-

ditions favoring its germination and growth for its integration into agroforestry practices and thus its domestication. Hence the interest of this study, which has the theme: “Germination Potential of *Ricinodendron heudelotii* (Baill.) Pierre ex Pax (Euphorbiaceae) Seeds in a Nursery in Soubré, Southwestern Côte d’Ivoire.”

This study focuses on the processes of reducing the germination time and increasing the germination rate of *Ricinodendron heudelotii* seeds in the nursery.

The general objective of the study is to contribute to the improvement of the germination potential from the perspective of sustainable agroforestry and thus its domestication.

Specifically, it aims to:

- Determine the treatment likely to increase the germination rate of the seed;
- Determine the treatment that can reduce the time and duration of seed germination.

2. Materials and Methods

2.1. Geographical and Administrative Location of the Study Area

This study was conducted in the department of Soubré, a locality situated in the southwestern region of Côte d’Ivoire, approximately 366 km from Abidjan, the economic capital. Soubré is the departmental seat of the Nawa Region. The Nawa Region shares borders with the Gbôklè and San-Pedro Regions to the south, the Cavally Region to the west, the Guémon and Haut Sassandra Regions to the north, and the Gôh and Lôh Guiboua Regions to the east. The Nawa Region comprises four (04) departments, namely Soubré, Buyo, Méagui, and Gueyo. The department of Soubré is located between longitudes 6°19' and 6°57' West and latitudes 5°26' and 6°13' North, covering an area of 4779 km² [8]. It includes four (4) sub-prefectures: Grand-Zattry, Okrouyo, Liliyo, and Soubré. It is bordered to the north by the Issia department; to the south by the Méagui and Sassandra departments; to the east by the Gagnoa and Gueyo departments; and to the west by the Buyo department.

The climate is sub-equatorial, characterized by two rainy seasons occurring between April-June and September-November, and two dry seasons between July-August and December-March. Rainfall is abundant, ranging from 1600 mm to 1800 mm, peaking in June. The temperature fluctuates between 26°C and 32°C throughout the year [8].

The soils encountered have a clayey and loamy texture. They are generally ferallitic soils, strongly and moderately reworked, with cover derived from schists and granites, or pseudogleyic and cambisols [9]. The horizons are thin, humiferous, but rich in organic matter and well-structured under dense forest. These soils are suitable for cultivating cocoa, coffee, oil palm, and rubber [9].

The main vegetation formations encountered are gallery forests, secondary forests, swamp formations, fallows, and formerly cultivated areas. Gallery forests border the various tributaries of the Sassandra River. Their floristic composition is often quite distinctive. Depending on their level of conservation, characteristic

species such as *Uapaca heudelotii* Baill., *Uapaca guineensis* Müll. Arg., *Macaranga* spp., *Napoleonaea vogelii* Hook. & Planch., and *Pterocarpus santalinoides* L'Hér. ex DC. are found [10].

2.2. Materials

Two types of materials were used to conduct this study: biological materials and technical materials. The biological material consisted of *Ricinodendron heudelotii* seeds. Regarding the technical materials, we used technical equipment, 96% concentrated sulfuric acid, and gibberellin (GA3). This set of materials is listed in **Table 1**.

Table 1. List of technical materials.

| Technical Materials | |
|--|--|
| Description | Use |
| Polyethylene nursery bags, 10 cm × 20 cm | Seedling or transplanting substrate contains |
| A hammer and a file | Mechanical seed scarification: |
| A watering can | Seedling irrigation |
| Basins | Seed soaking and pulp removal |
| Substrate | Humus soil as a seedling substrate |
| Glass containers | Seed soaking in sulfuric acid and gibberellin. |
| A screen | Sieving the substrate |
| Cooking pot | Boiling water treatment |
| Butane gas | Source of heat to boil water |

2.3. Methodology

To determine the germination potential of *Ricinodendron heudelotii* seeds, treatments were performed on them before sowing. For this purpose, mature fruits of the species were collected under mother trees in the Béssso classified forest in the Mé region, southeastern Côte d'Ivoire. These fruits were conditioned in jute bags and then transported to the experimental site, where they were stored in the open air under shade and watered every two days for a period of two to three weeks to promote pulp rotting and depulping for seed extraction. The seeds were then dried for three days and soaked in a basin of water for a purity test to separate healthy seeds (submerged seeds) likely to germinate from those in poor condition or abortive (floating seeds).

The supposedly healthy seeds were used to constitute the sample for the germination test, with the implementation of fourteen treatments (including the control treatment) before sowing to determine the one(s) conducive to germination.

2.3.1. Sample and Experimental Design

The experiment was set up according to a completely randomized block design with 3 repetitions. Each block includes 14 treatments (T0 to T14) applied to seeds

from the purity test. Each treatment consists of 10 presumed high-quality *Ricinodendron heudelotii* seeds that have not lost their germination ability, each sown in a polyethylene nursery bag filled with the same soil substrate. In total, 420 *Ricinodendron heudelotii* seeds ($14 \times 10 \times 3$) from the purity test were randomly allocated and used in this trial (Figure 1). The different treatments are as follows:

T0: no treatment (seeds directly sown)

T1: Scarification with a file, a slit is made at the apex of the seed.

T2: seed soaking in gibberellin (GA3) at 0.5 mg/l (24 h)

T3: seed soaking in gibberellin at 1 mg/l (24 h)

T4: seed soaking in gibberellin at 2 mg/l (24 h)

T5: scarified seeds soaked in gibberellin at 0.5 mg/l (24 h)

T6: scarified seeds soaked in gibberellin at 1 mg/l (24 h)

T7: scarified seeds soaked in gibberellin at 2 mg/l (24 h)

T8: seeds soaked in sulfuric acid (H₂SO₄) for 3 minutes.

T9: seeds soaked in sulfuric acid for 6 minutes

T10: seeds soaked in sulfuric acid for 12 minutes

T11: seeds immersed in water for 3 days

T12: seeds immersed in water for 7 days

T13: seeds soaked in boiling water at 100°C

The treated seeds were then sown in bags filled with the same type of potting soil. Seeded bags were arranged by treatment and uniformly watered twice daily: once between 6:00 and 8:00 a.m. and again between 4:00 and 6:00 p.m. Observations were made on the seeds over a 45-day period, during which the following data were collected: the start and end dates of germination for each group and test, and the number of germinated seedlings per group and per test recorded daily until germination was complete. At the end of the study, germination rates, delay, and duration for each test were calculated.

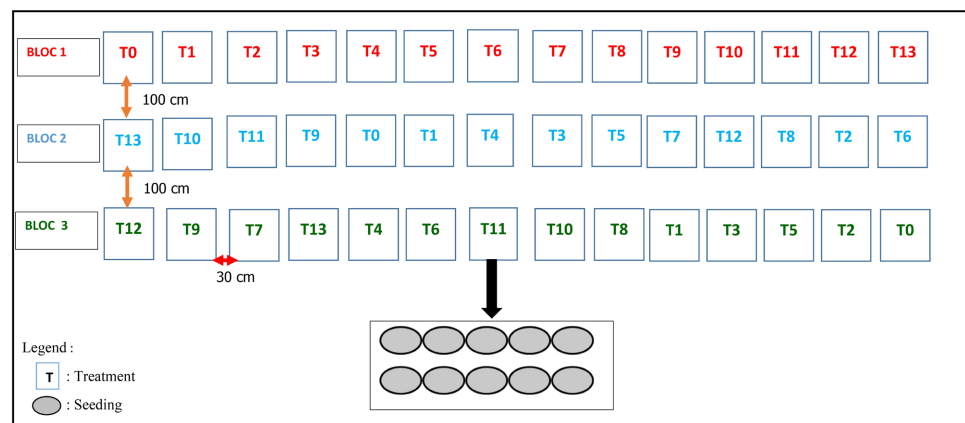


Figure 1. Diagram of the experimental setup.

2.3.2. Observations and Data Collection

The data collected during this study are the rate, delay, and duration of germination.

- **Germination Delay (DLG)**

This is the time elapsed between the sowing date and the emergence date of a seed in a seed lot; it is expressed in days and is obtained by observation.

$$DLG = tl - ts \quad (1)$$

tl : emergence date; ts : sowing date

- **Germination Rate (TG)**

This allows determination of the number of germinated seeds in a batch of planted seeds. The germination rate was evaluated for each treatment by counting the germinated seeds. The rate was determined by the formula below:

$$TG = \frac{ni}{N} \times 100 \quad (2)$$

TG: Germination rate of treatment i ; ni : Number of germinated seeds; and N : total number of seeds sown for treatment i .

- **Germination Duration (DG)**

These data allow us to determine whether there is grouped or dispersed germination per treatment. For each treatment, the germination duration (DG) was determined using the formula below:

$$DG = td - tp \quad (3)$$

This is the time difference between the first emergence (tp) and the last emergence (td) of a seed lot; it is obtained by observation.

2.4. Statistical Analysis Methods

Analysis of variance (ANOVA) was used in this study to compare the means of germination parameters (rate, delay, duration). This parametric test requires the data to follow a normal distribution, which was previously verified using the Shapiro-Wilk normality test. The objective of the analysis is to determine whether the means of the values measured in different germination tests are significant. Before proceeding with the ANOVA test, three other tests were conducted to check the normality of the data, their distribution, and the homogeneity of variances. First, the Shapiro-Wilk normality test was performed to check for normality. Then, when the distribution followed a normal law, the Levene test was conducted to verify the homogeneity of variances. Finally, the Tukey test was carried out to compare the means in pairs and assess the significant differences between them when the calculated probability was significantly different. Regarding the obtained data, the ANOVA tests enabled us to obtain the means between the germination parameters. The Kruskal-Wallis test was used to classify the means with a probability threshold of 5%. The R software was used to perform all these statistical tests. Excel 2021 was used to enter the collected data.

3. Results and Discussion

3.1. Results

3.1.1. Germination Rate

The results after analysis showed that there is a significant difference between the

different germination rates ($P < 0.05$) in **Table 2**. However, the treatments by scarification, soaking in tap water (for 7 days), and seeds soaked in sulfuric acid for 12 minutes gave the best germination rates, which were 51.66%, 43.33%, and 30%, respectively, compared to the control (11%) in **Figure 2**. Moreover, intermediate germination rates of 21%, 18%, and 15% higher than the control treatment rate are recorded, respectively, with sulfuric acid treatments for 6 minutes, gibberellin at 2 mg/l (24 h), and sulfuric acid for 3 minutes in **Table 2**.

Table 2. Mean values of *Ricinodendron heudelotii* germination parameters according to treatments.

| Treatments | Rate (%) | Delay (days) | Duration (days) |
|-----------------|-----------------|-----------------|-----------------|
| T0 | 11.00 ± 1.15 d | 23.00 ± 0.58 a | 9.00 ± 1.15 b |
| T1 | 51.66 ± 0.00 a | 10.00 ± 0.00 e | 8.00 ± 0.00 b |
| T2 | 10.67 ± 0.67 d | 15.33 ± 0.33 b | 8.33 ± 0.88 b |
| T3 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| T4 | 18.67 ± 1.20 b | 10.00 ± 0.00 d | 5.00 ± 1.15 c |
| T5 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| T6 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| T7 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| T8 | 15.00 ± 0.58 c | 15.67 ± 0.88 b | 6.33 ± 0.33 bc |
| T9 | 21.00 ± 1.53 ab | 14.00 ± 0.00 c | 12.00 ± 0.00 a |
| T10 | 30.00 ± 1.15 a | 12.67 ± 0.67 cd | 6.67 ± 0.67 bc |
| T11 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| T12 | 43.33 ± 0.88 a | 13.00 ± 0.67 cd | 11.00 ± 1.00 b |
| T13 | 0.00 ± 0.00 e | 0.00 ± 0.00 e | 0.00 ± 0.00 d |
| General average | 8.69 ± 1.43 | 7.95 ± 1.33 | 3.95 ± 0.76 |
| Test statistics | p = 0.01 | p = 0.006 | p = 0.00 |

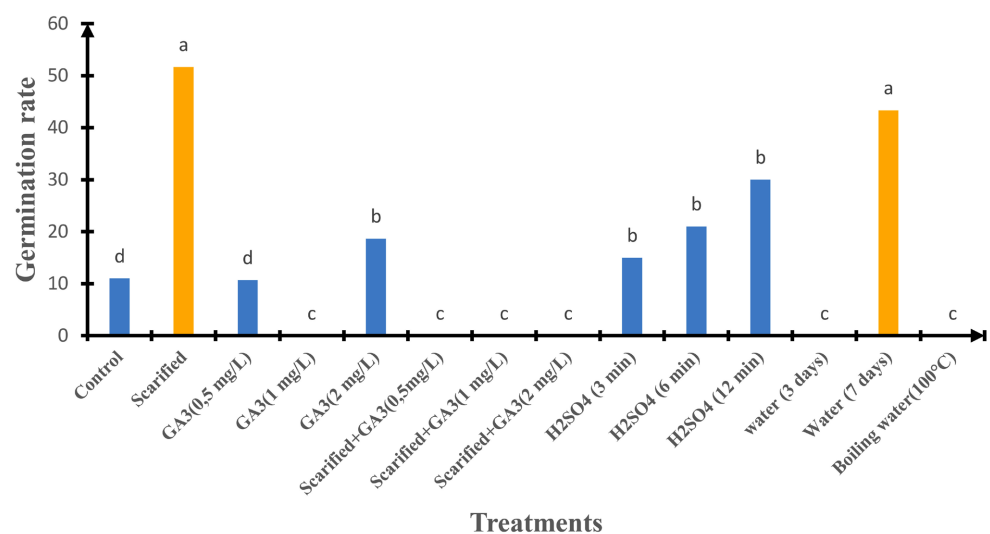


Figure 2. Germination rate of *Ricinodendron heudelotii* seed as a function of treatments.

3.1.2. Germination Delay

Treatments with scarification and gibberellin at 2 mg/L significantly reduced the seed germination time to 10 days compared to the control seeds, which had a germination delay of 23 days in **Figure 3**. Besides these two treatments, the treatments with gibberellin at 2 mg/L and sulfuric acid for 6 and 12 minutes also shortened this delay to 13 to 14 days (**Table 2**). The difference in germination delays between treatments is statistically significant, as indicated by the analysis of variance results with a probability (p-value = 0.006) below the threshold of 0.05 in **Table 2**.

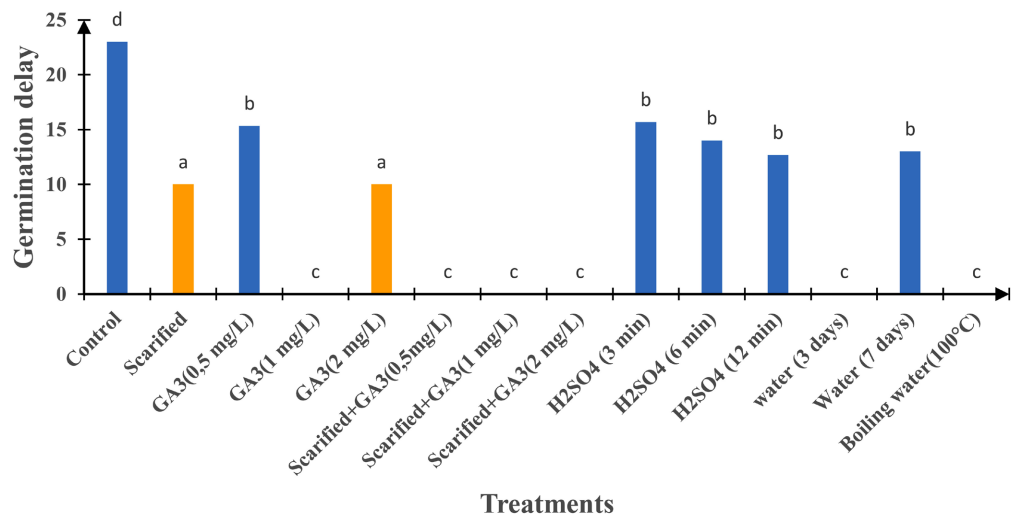


Figure 3. Germination delay of *Ricinodendron heudelotii* seed as a function of treatments.

3.1.3. Germination Time

The results showed that treatments with scarification, gibberellic acid (0.5 mg/L and 2 mg/L), sulfuric acid (3 minutes and 12 minutes), and tap water for 7 days resulted in clustered germination over a period of 5 to 11 days, falling within the same time range for germination as the control seeds in **Figure 4**. Statistical tests confirmed that the average germination durations under the treatments are significantly different ($p < 0.05$) in **Figure 4** and **Table 2**.

3.1.4. Combined Effect of Germination Parameters

Treatments involving scarification, sulfuric acid, and 7 days of tap water resulted in the highest germination rates (30% to 51.66%) within a short delay of 10 to 13 days, during a maximum germination period of 11 days in **Table 2**.

3.2. Discussion

In this study, although the sample of 30 seeds per treatment may be considered small, the results obtained do not differ much from those obtained by some authors. Notably, for the untreated seeds (control), the germination rate of 11% is close to the result obtained (9.89%) by [11] for the same species and (8%) by [12] for *Adansonia digitata*.

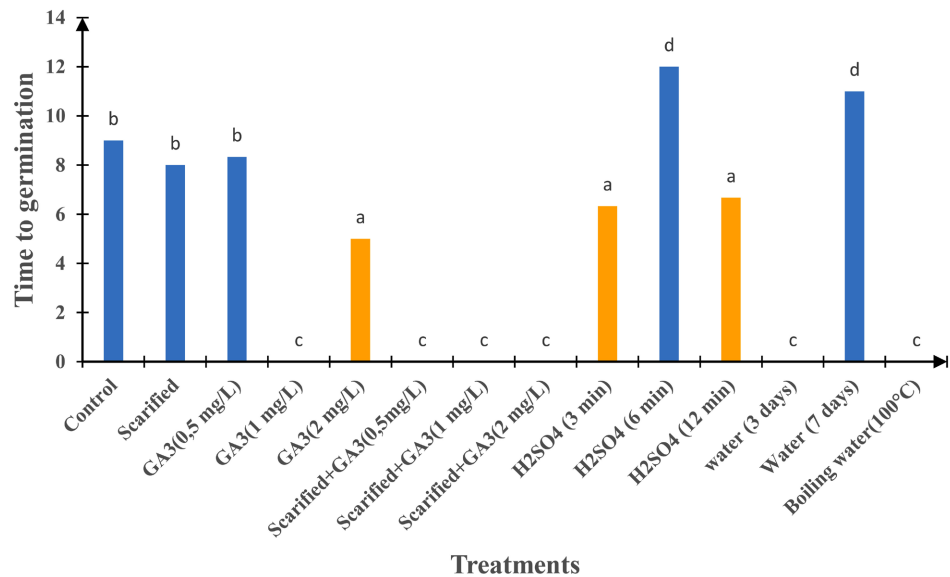


Figure 4. Germination duration of *Ricinodendron heudelotii* seed as a function of treatments.

The results of this study showed that the germination rate of *Ricinodendron heudelotii* seeds varied depending on the pre-sowing treatments. In fact, the highest germination rates were obtained with scarified seeds, soaked in water for 7 days, and treated with sulfuric acid for 12 minutes. These results could be explained by the fact that these methods weaken the hard shell of *R. heudelotii* seeds, thus favoring the absorption of water by the seed that initiates germination.

These results corroborate those of [13] and [14], which indicate that sulfuric acid softens the seed coat, allowing water to enter and triggering the germination process, due to its ability to remove the hard layer of the seed coat. Additionally, sulfuric acid also stimulates the biochemical and physiological activities necessary for germination [15]. However, seeds soaked in sulfuric acid showed a germination rate of 30%. It is possible that the 12-minute immersion time in the acid may not have been sufficient to weaken the shell of *Ricinodendron heudelotii* seeds. As demonstrated by [16]-[18], certain species can tolerate significant variations in immersion time in concentrated sulfuric acid (94° - 96°). Indeed, [15] showed that for *Acacia polycantha*, the optimal pretreatment is an immersion of 60 minutes (1 hour) in acid. For *Dichrostachys cinerea*, it is 30 minutes in acid. In comparison with the present study, it can be concluded that the seeds of *Ricinodendron heudelotii*, being very hard and resistant, consequently, a longer immersion in sulfuric acid (96%) for a duration of 40 to 60 minutes might potentially increase the germination rate.

Similar to this chemical treatment, scarification enhances water permeability at the seed level due to the split made to trigger the physiological process of germination, for which moisture is an essential factor. This explanation could also justify the germination rate (43%) recorded in seeds soaked in water for 7 days, whose effect would have favored water permeability by softening the seed coat. Soaking treatments in tap water for 7 days and scarification likely facilitate water

absorption by the seed, triggering metabolic reactions in the embryo and promoting the rapid emergence of seedlings. In their study on the effect of seed pretreatments on the germination of *Prosopis africana* (Guill., Perrot, & Rich.) Taub. (Fabaceae), [19] also confirmed that these treatments stimulate the germination of *Prosopis africana*. The results of this study are in agreement with those of [20], which reported that soaking and scarification reduce the germination time. The results of this study are in accordance with those of [14], which reported that soaking and scarification reduce germination time. These methods reduced the germination time to 10 - 13 days compared to the control seeds (23 days) and the natural germination time of *R. heudelotii* (34 days) reported by [3]. These results are also consistent with those of [2] on the germination of the same species.

These results are confirmed by [20] through their work on the germination of *Prosopis africana* (Guill., Perrot. and Rich.) Taub. (Fabaceae). These authors showed that scarification increases the germination rate of *Prosopis africana*. Moreover, it shortened the germination period of the species. This observation was made during this study on the seeds of *R. heudelotii* with the three treatments that yielded the best germination rates (scarification, sulfuric acid for 12 minutes, and water for 7 days). These results could be explained by the fact that the permeability of water at the seed level under the effect of these treatments triggers the germination process. This process begins with imbibition and then the action of enzymes, which takes place in an aqueous medium to mobilize the nutrient elements stored in the dormant seed to ensure the growth of the radicle and to produce the root of the young plant. Hence, the indispensable role of water in germination. The result of treating the seeds with water for 7 days obtained at the level of the germination rate and the time to germination serves as evidence, as shown by [21] as well as [22] in their work on *R. heudelotii*. The latter affirm that soaking and scarification reduce the germination time.

Ambient water is among the treatments capable of softening the seed coat, making it permeable to initiate germination, as confirmed by the results of this study. Similarly, those in [23] confirmed this by reporting that soaking in water at ambient temperature improves the germination of tropical tree seeds.

In light of these observations and the advantages of this treatment due to its inexpensive, non-laborious practice, and without any risk incurred by the operator, as well as the destruction of seeds, it is advisable to recommend the treatment of seeds by soaking in water for 7 days to growers for the production of *Ricinodendron heudelotii* plants for its domestication.

4. Conclusion

This study revealed that treatments by scarification and soaking with tap water for 7 days significantly increased the germination rate of *Ricinodendron heudelotii* seeds with 56.67% and 43.33%, respectively, within a short period of 10 to 13 days, during a maximum germination period of 11 days. However, we recommend that growers soak with tap water for 7 days for the production of *Ricinodendron heu-*

delotii seedlings for its integration into agroforestry for sustainable conservation. In fact, this process is less laborious; in addition, it does not present a risk of destruction of the embryo and does not require a large volume of work hours.

Author Contributions

Affessi Alain Jiani GITTE and Souleymane SANOGO planned the experiments, which were conducted by Affessi Alain Jiani GITTE. Coulibaly Souleymane interpreted the results. Affessi Alain Jiani GITTE wrote up the manuscript, statistically analyzed the data, and prepared the illustrations.

Data Availability

Data presented in this study will be available upon a fair request to the corresponding author.

Conflicts of Interest

All authors declare no conflicts of interest.

References

- [1] Dupriez, H. and De Leener, P. (1993) Trees and Multi-Storey Agriculture in Africa. CTA, 280 p. <https://www.cabidigitallibrary.org/doi/epdf/10.5555/19950616935>
- [2] Kouamé, N.M.T., Gnahoua, G.M. and Mangara, A. (2012) Domestication Trial of *Ricinodendron heudelotii* in the Fromager Region (Côte d'Ivoire). *Journal of Applied Biosciences*, **56**, 4133-4141.
- [3] Saki, S.J., Mosso, K., Sea, T.B. and Diopoh, K.J. (2005) Determination of Some Essential Components of Akpi Almonds (*Ricinodendron heudelotii*) in Côte d'Ivoire. *African Agronomy, Series 17*, **2**, 137-142.
- [4] Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., *et al.* (2005) Global Consequences of Land Use. *Science*, **309**, 570-574. <https://doi.org/10.1126/science.1111772>
- [5] Djeugap, F., Bernier, L., Dostaler, D., Khasa, D., Fontem, D. and Nwaga, D. (2013) Agroforestry Opportunities and Constraints of *Ricinodendron heudelotii* in Cameroon. *International Journal of Biological and Chemical Sciences*, **7**, 344-355. <https://doi.org/10.4314/ijbcs.v7i1.30>
- [6] Djaha, A.J. and Gnahoua, G.M. (2014) Contribution to the Inventory and Domestication of Wild Food Species in Côte d'Ivoire: The Case of the Departments of Agboville and Oumé. *Journal of Applied Biosciences*, **78**, 6620-6629. <https://doi.org/10.4314/jab.v78i1.8>
- [7] Shiembo, P.N. (1994) Domestication of Multipurpose Tropical Plants with Particular Reference to *Irvingia gabonensis* (Baill), *Ricinodendron heudelotii* (Baill) and *Gnetum africanum* Welw. MSc. Thesis, University of Edinburgh, 124 p.
- [8] Louan, O.B., Tanina, D.S., Marie, P.H. and Gnamba, S.D. (2022) Effect of the Addition of Agricultural Inputs on the Water-Sediment Pair of Cocoa-Growing Areas in Yabayo in the Department of Soubré in the South-West of Côte d'Ivoire. *Revue Ivory Scientific Technology*, **40**, 43-56.
- [9] Duchaufour, P. (1995) Pedology. Soil, Vegetation, Environment. 4th Edition, Abrégés

Masson, 324 p.

- [10] Kouadio, Y.J., Cissé, A., Bruno Kpangui, K., e Tiébré, M. and Edouard N'Guessan, K. (2021) Process of Creating a Biodiversity Conservation Area on the Soubré Hydroelectric Dam, Southwest Côte d'Ivoire. *European Scientific Journal*, **17**, 56-76. <https://doi.org/10.19044/esj.2021.v17n40p56>
- [11] Boko-Haya, Y.Y., Ouinsavi, C.A.I.N., Ewédjè, E.B.K., Akin, Y.Y., Zinkpe, T. and Agbangla, C. (2021) Variability of Seed Germination and Seedling Growth Potential of *Ricinodendron heudelotii* (Euphorbiaceae) at Fine Scale in Southern of Benin. *East African Journal of Forestry and Agroforestry*, **3**, 270. <https://doi.org/10.37284/eajfa.3.1.270>
- [12] Falemara, B.C., Chomini, M.S., Thlama, D.M. and Udenkwere, M. (2014) Germination Response of Baobab Seeds (*Adansonia digitata* L.) as Influenced by Three Pre-treatment Techniques. Forest Industry in a Dynamic Global Environment. *Proceedings of the 35th Annual Conference of Forestry Association of Nigeria*, Sokoto, Vol. 2, 31-41.
- [13] Razanameharizaka, J., Ravelomanana, D. and Grouzis, M. (2001) Germination of Seeds of *Adansonia rubrostipa* Jum. and *H. perrier*. In: *Proceedings of the Research Days Antananarivo*, Ministry of Higher Education, 9 p.
- [14] Amusa, T.O. (2011) Effects of Three Pre-Treatment Techniques on Dormancy and Germination of Seeds of *Azelia africana* (Sm. ex pers.). *Journal of Horticulture and Forestry*, **3**, 96-103.
- [15] Agbogidi, O.M., Bosah, B.O. and Eshegbeyi, O.F. (2007) Effects of Acid Pre-Treatment on the Germination and Seedling Growth of African Pear (*Dacryodes edulis* Don. G. Lam. H.J.). *International Journal of Agricultural Research*, **2**, 952-958. <https://doi.org/10.3923/ijar.2007.952.958>
- [16] Akinyele, A.O. and Ibeh, K.G. (2020) Effect of Pawpaw Latex, Plantain Stem Juice and Sulphuric Acid on Seed Germination of *Albizia lebbek* (L.) Benth. *Journal of Research in Forestry, Wildlife & Environment*, **12**, 277-285.
- [17] Dantani, A., Mukhtar, R., Musa, A., Gupa, M. and Wali, B. (2019) Assessment of Pre-Sowing Treatments on Germination and Early Growth of Tamarind (*Tamarindus indica* L.) in Kano State Nigeria. *South Asian Journal of Biological Research*, **3**, 18-27.
- [18] Guimbo, I.D., Barage, M. and Douma, S. (2011) Preliminary Studies on the Food Use of Spontaneous Plants in the Peripheral Areas of Niger's W Park. *International Journal of Biological and Chemical Sciences*, **6**, 4007-4017.
- [19] Mojeremane, W., Makgobota, K., Teketay, D., Rampart, M., Mmolotsi, R., Kopong, I., Monekwe, D., et al. (2020) Germination Studies on Seeds of *Burkea africana* and *Erythrophleum africanum* from Kazuma Forest Reserve, Northern Botswana. *African Journal of Biotechnology*, **19**, 675-683.
- [20] Ahoton, L.E., Adjakpa, J.B., M'Po, I.M. and Akpo, E.L. (2009) Effect of Seed Pre-Treatments on the Germination of *Prosopis africana* (Guill., Perrot et Rich.) Taub. (Césalpiniciées). *Tropicultura*, **27**, 233-238.
- [21] Moussa, A., Koko, D.E.I.K. and Fandohan, B.A. (2020) Domestication de *Ricinodendron heudelotii* (Baill.) Pierre ex Heckel: Savoirs traditionnels, germination et croissance des jeunes plants en milieu contrôlé. *Revue Ivoirienne des Sciences et Technologies*, **35**, 247-269.
- [22] Ouattara, N., Kouassi, B.A.T., Soro, D. and Soro, D. (2019) Effect of Pretreatments on the Dormancy of *Acacia auriculiformis* Seeds A. Cunn ex. Benth. (Fabaceae). *Eu-*

ropean Scientific Journal, **15**, 202-215. <https://doi.org/10.19044/esj.2019.v15n18p202>

- [23] Louppe, D. and Ouattara, N. (1993) Sulphuric Acid Pre-Treatment and Seeding Depth. Activity Report, IDEFOR, Forestry Department, Korhogo Branch, 8 p.