World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Multiplication and development in the nursery of *Pterocarpus erinaceus,* an endangered agroforestry species in Cote d'Ivoire

Golou Gizèle ZANH [1,*], Lisette Zeh TOKPA [2], Kouame Jean-Marc KOUMAN [1], Claude Bernard AKE [1] and Yao Sadaiou Sabas BARIMA [1]

[1] *Biodiversity and Tropical Ecology Laboratory, Environmental Training and Research Unit, Jean Lorougnon Guédé University, BP 150, Daloa, Côte d'Ivoire*
[2] *Laboratory for the Amelioration of Agricultural Production, Agroforestry Training and Research Unit, Jean Lorougnon Guédé University, BP 150, Daloa, Côte d'Ivoire.*

World Journal of Advanced Research and Reviews, 2024, 24(01), 2250–2256

Publication history: Received on 12 September 2024; revised on 19 October 2024; accepted on 21 October 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.1.3223

Abstract

Pterocarpus erinaceus is a multi-purpose species threatened with extinction. The present study aims to contribute to the improvement of multiplication and nursery growth of *Pterocarpus erinaceus* hulled seeds. To this end, four pre-treatments were applied to *Pterocarpus erinaceus* hulled seeds to lift their dormancy in order to facilitate germination of the species. These were: untreated seeds as Control (To), soaking in ordinary water for 24 h (T1), soaking in hot water at 60°C (T2) and soaking in sulfuric acid (H2SO4) for 20 min (T3). Germination parameters such as germination rate, germination time and average germination time were evaluated. Growth in height, diameter, number of leaves and root length were determined. Germination data and growth parameters were collected. Analyses showed that soaking shelled seeds in ordinary water for 24 h was the best treatment, with a germination rate of 43%. Pre-treatment of the seeds with sulfuric acid for 20 min showed the lowest germination rate (1%), due to the sensitivity of the seeds. Furthermore, these pre-treatments had no effect on seedling growth in the nursery. Those interested in producing *Pterocarpus erinaceus* seedlings are advised to soak shelled seeds in ordinary water for 24 hours to ensure better germination in the nursery.

Keywords: Endangered species; Germination improvement; Nursery growth; *Pterocarpus erinaceus*; Côte d'Ivoire

1. Introduction

Pterocarpus erinaceus Poir. commonly known in Côte d'Ivoire as "Vene" is a legume belonging to the Fabaceae family. It is endemic to the Guinean-Sudanese and Sudano-Sahelian savannahs [1]. In Côte d'Ivoire, its range lies mainly north of the 8th parallel, which includes the Sudan zone [2]. *Pterocarpus erinaceus* is a multi-purpose species [3]. This species is of great socio-economic and ecological interest. Its bark is used in traditional medicine for ulcer dressings, scalp treatment and the treatment of diarrhoea [4]. Its leaves are used to treat malaria and as a food supplement. The roots are used to treat anemia, hemorrhoids and painful menstruation [5, 6]. The leaves are sold on the market as fodder for cattle [7]. The species is much sought-after for both its quality and the color of its wood, which varies from pink-red to dark brown [8, 9]. In agroforestry, *Pterocarpus erinaceus* improves soil fertility [10]. This range of uses has led to the overexploitation of *Pterocarpus erinaceus* in Côte d'Ivoire, making it an endangered species in Ivorian savannic zones [11]. This observation has led to the need to find ways of multiplying the species in nurseries in order to contribute to its conservation. In Burkina Faso, the work of Touré [12] has shown that the low germination rate of *Pterocarpus erinaceus* is a hindrance to the multiplication of the species. In Côte d'Ivoire, work by Bamba *et al.* [2] has shown that hulled seeds have the best germination rate. However, few studies have combined the pretreatments defined by Bamba

* Corresponding author: Golou Gizèle ZANH

et al. [2] with the application of chemicals, notably sulfuric acid, to lift the dormancy of hulled *Pterocarpus erinaceus* seeds. However, few studies have shown the effect of these treatments on the growth of *Pterocarpus erinaceus* seedlings. It is in this context that this study proposes to contribute to the improvement of multiplication and nursery growth of dehulled *Pterocarpus erinaceus* seeds through the application of four dormancy-breaking pre-treatments to the seeds. At the end of the study, the best pre-treatment to be applied to hulled seeds will be proposed to stakeholders interested in the production of *Pterocarpus erinaceus* seedlings to ensure the multiplication of the species in Côte d'Ivoire.

2. Material and methods

2.1. Material

The study material consisted of vegetal material and technical equipment.

The vegetal material consisted mainly of seeds (Figure A) and seedlings (Figure B) of *Pterocarpus erinaceus* (Figure 1).

Figure 1 *Pterocarpus erinaceus* hulled seeds and seedlings

To carry out this experiment, the following technical equipment was used:

- a graduated ruler and digital calipers for measuring seedlings ;
- 20 x 10 cm polyethylene bags for storing potting soil in the nursery;
- sulfuric acid (H2SO4)

2.2. Methods

2.2.1. Pretreatment of Pterocarpus erinaceus hulled seeds

Four (04) pre-treatments were applied to hulled seeds based on the work of Bamba *et al.* [2] to promote germination:

Untreated seeds as Control (To): Seeds were planted directly into the bags without pre-treatment.

Soaking in ordinary water for 24 h (T1): Seeds were soaked in ordinary water in a container, then removed 24 h later and placed directly in the bags.

Soaking in hot water at 60°C (T2): Seeds were soaked in water heated to 60°c and contained in a bucket until completely cooled, then placed directly in soil.

Soaking in sulfuric acid (H_2SO_4) for 20 min (T3): Seeds were soaked in sulfuric acid for 20 min, then rinsed with plain water and placed directly in the bags.

2.2.2. Seed sowing and trial monitoring

Seeds were sown directly into black polyethylene bags measuring 20 x 10 cm with holes, containing a mixture of forest soil and sawdust, arranged in rows under a shady canopy, sheltered from direct sunlight. A total of 400 seeds (100 seeds per pre-treatment) were sown. The *Pterocarpus erinaceus* beds were watered twice a day (morning and evening) for one month. During the trial period, the number of seeds germinated per pre-treatment was counted daily. Seed observations ended when no germination was observed after two successive counts.

2.2.3. Evaluation of Pterocarpus erinaceus growth

After germination, growth parameters (plant height, diameter and number of leaves) were measured on the seedlings, in order to determine seedling vigour. Plant height was measured with a ruler graduated in centimetres. The diameter at the collar was determined with an electronic caliper in millimetres. The number of leaves was determined by counting. Measurements were taken every 14 days for 90 days. Root length was also measured using a 1 mm tape measure.

2.2.4. Data analysis

Descriptive statistics were used to determine:

- Germination dynamics or germination speed, i.e. the cumulative number of seeds germinated daily during the entire germination period of a set of batches [13].
- Germination rate is used to assess the germination potential of *Pterocarpus eracineus* seeds. It is defined as the ratio of the number of germinated seeds (ni) per day to the total number of seeds sown (N). It is expressed as a percentage
- Total germination time (DTG) is the time between the date of the first germination and the date of the last germination;
- Germination delay (*DG*) is the time in days between sowing and germination of each seed in a batch. It corresponds to the number of days required for germination of each seed sown [13].

DG (d) = Tn-T0; DG (d) = Germination delay in days; T1 = Date of germination of each seed; T0 = Date of sowing of seeds.

Graphs were used to analyze daily seed germination and the germination rate of the different pretreatments.

A one-factor analysis of variance (ANOVA 1) was performed on growth parameters to determine the effect of different pre-treatments on seedling development.

3. Results

3.1. Germination dynamics of dehulled *Pterocarpus erinaceus* seeds

Figure 2 shows the daily germination dynamics according to the pre-treatments applied to the seeds. Seeds pre-treated with ordinary water for 24h (T1) and hot water at 60° C (T2) had a higher number of germinated seeds per day than those treated with sulfuric acid for 20 min (T3) and the control (T0). In fact, the number of initial germinations was recorded for seeds soaked in ordinary water for 24h, which began on the 7th day after sowing with one (01) germinating seed. Germination of seeds soaked in hot water at 60°C began on day 9 after sowing, with 7 seeds germinating. Seed germination without pre-treatment (control) began on day 11 with one seed. Seeds treated with sulfuric acid for 20 min began to germinate on day 13 after sowing, with one seed. Seed germination stabilized on days 13, 15, 17 and 19 after sowing, respectively for seeds soaked in sulfuric acid for 20 min, the control, seeds soaked in hot water at 60°C and those soaked in ordinary water for 24 hours. After these dates, the seeds no longer germinate.

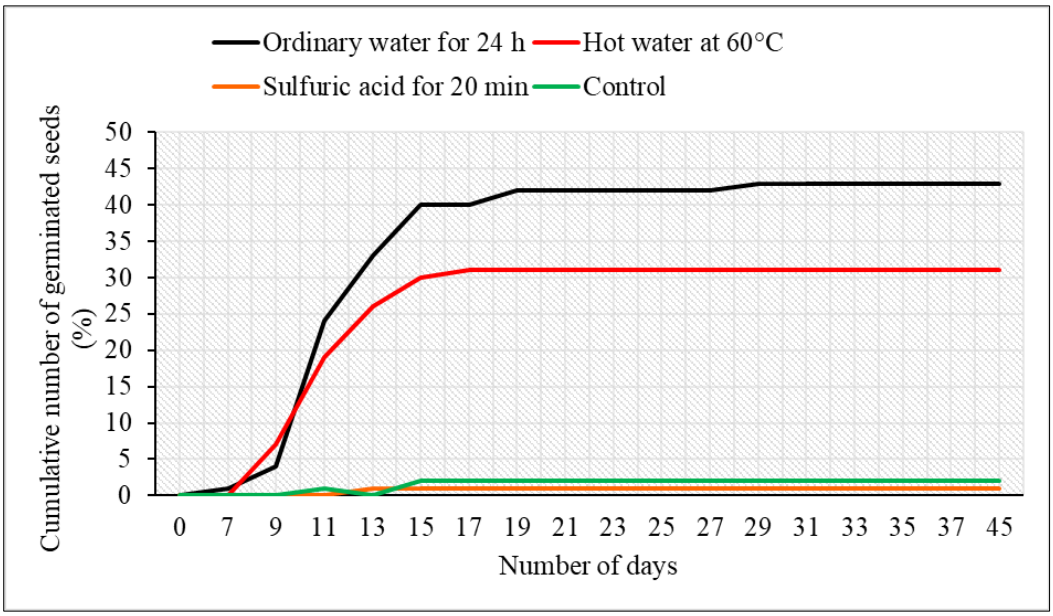

Figure 2 Germination dynamics of *Pterocarpus erinaceus* as function of pretreatment.

3.2. Germination rate of dehulled *Pterocarpus erinaceus* seeds

Pre-treatment with ordinary water for 24 h recorded a higher germination rate than the other three pre-treatments. In fact, pretreatment with ordinary water for 24h recorded a germination rate of 43%. Pre-treatment with hot water at 60°C recorded a germination rate of 31%. On the other hand, pre-treatment with sulfuric acid for 20 min and the control recorded germination rates of 1% and 2% respectively (Figure 3).

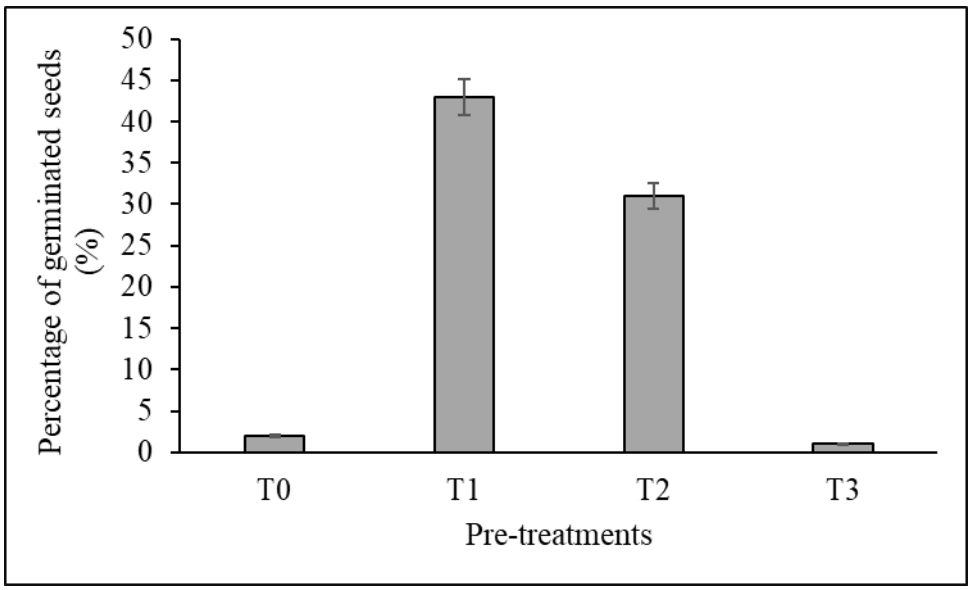

Figure 3 Germination rate of dehulled *Pterocarpus erinaceus* seeds

T0: control; T1: pretreatment with ordinary water for 24 h; T2: pretreatment with hot water at 60°C; T3: pre-treatment with sulfuric acid for 20 min.

3.3. Germination time and *duration* of dehulled *Pterocarpus erinaceus* seeds

In terms of germination time, untreated seeds (T0) recorded the longest average germination time of 17 days, followed by seeds soaked in hot water at 60°C (T2) with an average time of 15.4 days. Seeds soaked in ordinary water for 24 h (T1) recorded an average delay of 14.71 days. Treatment with sulfuric acid for 20 min (T3) resulted in a germination delay of 13 days (Figure 4).

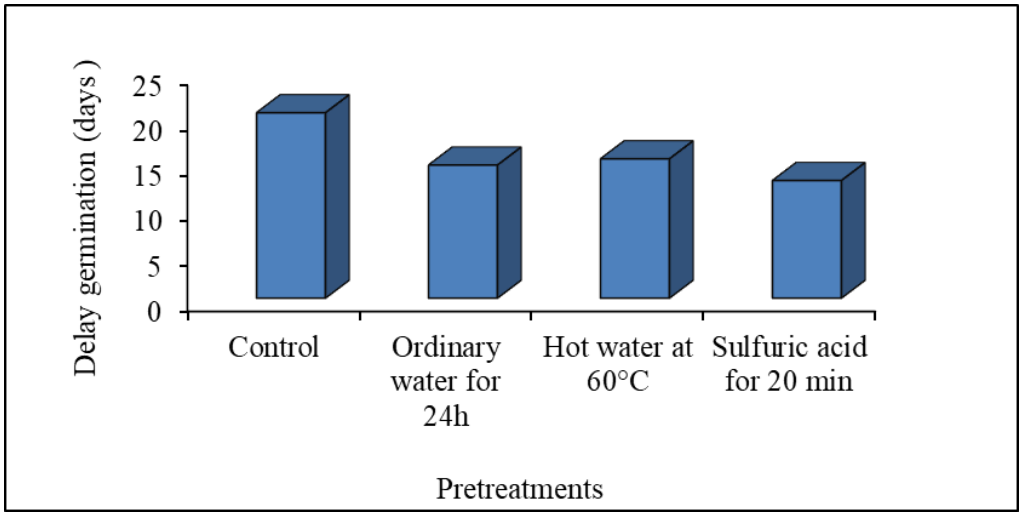

Figure 4 Average germination time of dehulled *Pterocarpus erinaceus* seeds

In terms of average germination time, pretreatment with ordinary water for 24 h gave the longest average time (22 days), followed by pretreatment with hot water at 60°C (21 days), no treatment (5 days) and sulfuric acid for 20 min (1 day), Figure 5.

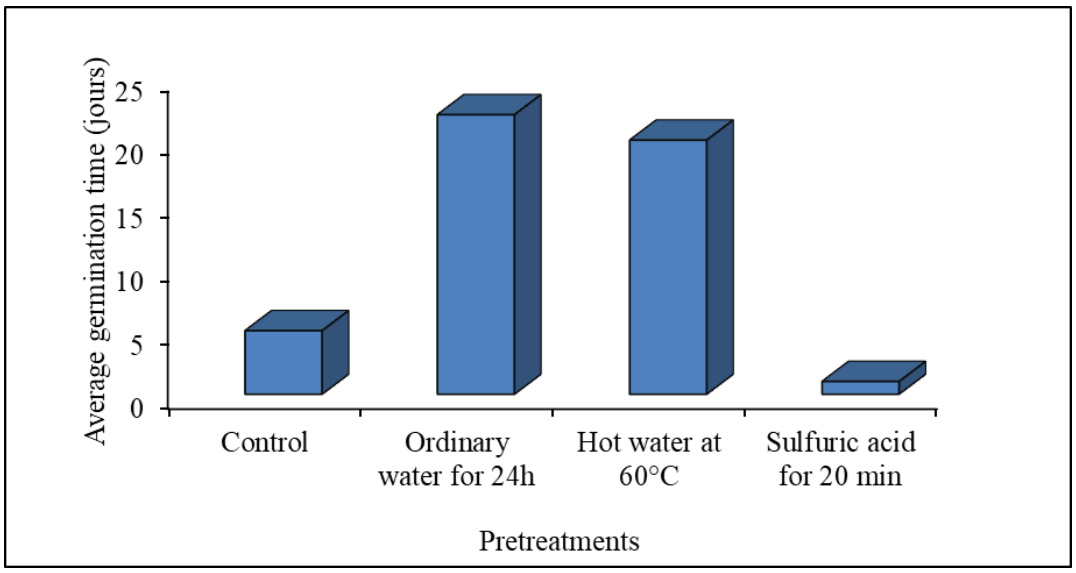

Figure 5 Average germination time of *Pterocarpus erinaceus dehulled seeds*

3.4. Effect of pre-treatment on *Pterocarpus erinaceus* seedling growth

As the seedlings of untreated seeds and those treated with sulfuric acid for 20 min did not survive, growth parameters were measured only on seeds treated with ordinary water for 24 h and those treated with hot water at 60° C. To this end, the average growth measurements of seedlings subjected to the different pre-treatments are presented in Table 1. Analysis of variance showed that the different pre-treatments had no significant effect on growth in height and diameter at the 5% threshold. The average number of leaves on seeds treated with ordinary water for 24 hours was identical to that on seeds treated with hot water at 60°C, with a value of 7.6 leaves. In fact, analysis of variance showed that the average of each pre-treatment was not significantly different from the other. These pre-treatments had no significant effect ($P>0.05$) on leaf production per seedling. As for average root length, the 60° C hot water pre-treatment recorded an average of 24 cm, compared with 23.75 cm for the 24 h ordinary water pre-treatment. This result shows that the different pre-treatments had no significant effect ($P>0.05$) on the root length (RL) of the seedlings.

Table 1 Effect of different pretreatments on seedling growth parameters

Growth parameters	Hot water at 60° C	Normal water for 24 h	Test statistics	P.value
Diameter at collar (mm)	1.00±0.42a	0.99±0.49a	0.02	0.88
Height (cm)	11.14±3.48a	10,89±3.57a	2.56	0.11
Number of leaves	7.61±3.5a	7.6±2.33a	0	0.99
Root length (cm)	24±4.14a	23.75±6.10a	0.01	0.92

On the same line, values followed by the same letter are statistically identical at the 5% threshold. mm: millimetre, cm: centimetre

4. Discussion

The present study showed that the different pre-treatments influenced germination parameters such as germination rate, growth time and germination duration of shelled *Pterocarpus erinaceus* seeds.

Ordinary water treatment of hulled *Pterocarpus erinaceus* seeds for 24 h recorded the best germination rates (43%). In fact, treatment with ordinary water for 24 h accelerated seed germination. The same observation was made by Smith *et al.* [14]. In their work, these authors showed that pre-treatment with ordinary water for 24 h helped to soften and hydrate the seeds, thus promoting optimal germination. In contrast to the studies carried out by Bamba *et al.* [2], unsoaked hulled seeds (T0) achieved a low germination rate of 2%. This low germination rate could be linked to environmental factors. On the other hand, treatment with sulfuric acid for 20 min recorded the shortest germination time. The same observation was made by Wang *et al* [15] in their study, who showed that treatment with sulfuric acid for 20 min would have resulted in a shorter germination time than treatments with hot water and plain water for 24 h. The shortest germination time was obtained with the 20 min sulfuric acid treatment, which lasted one (01) day. In fact, treatment with sulfuric acid for 20 min reduced germination time [16]. This could be explained by the fact that most of the seed embryos would be destroyed by the long soaking time of the seeds in concentrated sulfuric acid [17].

Analysis of the effect of the treatments on the growth parameters (height, diameter, number of leaves and root height) of *Pterocarpus erinaceus* revealed that there was no significant difference between the different treatments ($P > 0.005$). This could be attributed to early environmental conditions and seed germination [18]. According to Foley [18], key environmental factors regulate the variation and timing of germination in plant species. Also, according to the author, the sun may have had a randomizing effect on the samples studied. This would cause changes in the growth results of seed treatments [19].

5. Conclusion

The results obtained allow us to conclude that the different treatments had a significant effect on the germination of *P. erinaceus* seeds. However, no influence of the different treatments was observed in the growth of *P. erinaceus* seedlings. With regard to *P. erinaceus* germination, seeds treated with ordinary water for 24 h recorded the best germination rate of 43%, compared with soaking shelled seeds in hot water and sulfuric acid. On the other hand, the sulfuric acid treatment of the seeds was the worst, as only 1% of the seeds germinated following this treatment. Therefore, in order to promote optimal and uniform germination, soaking shelled *P. erinaceus* seeds in plain water for 24 h is the best pre-treatment for *P. erinaceus* germination.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest concerning the manuscript.

References

[1] Sylla SN, Samba RT, Neyra M, Ndoye I, Giraud E, Willems A, De Lajudie P, Dreyfus B. Phenotypic and Genotypic Diversity of Rhizobia Nodulating *Pterocarpus erinaceus* and *P. lucens* in Senegal. *Syst. Ap. Microbiol.* 2002; 25(4): 572–583

[2] Bamba N, Ouattara ND, Konan D, Bakayoko A, Tra Bi FH. Effects of five pretreatments on the germination of veneer (*Pterocarpus erinaceus* Poir., Fabaceae) in the Haut Bandama Reserve (Côte d'Ivoire). *Eur. Sci. J*. 2018; 4(30): 438-453

[3] Arbonnier M. Trees, shrubs and lianas of West African dry zones. Cirad, Margraf, MNHN; 2004.

[4] Adjonou K, Napo A, Adzo DK, Segla KN, Kouami K. Study of the dynamics of natural stands of *Pterocarpus erinaceus* Poir. (Fabaceae) overexploited in Togo. *Bois et Forêts des Tropiques*. 2010; 306(4):45-55.

[5] Ouédraogo N, Lompo M, Sawadogo RW, Tibiri A, Hay AE, Koudou J, Dijoux MG, Guissou I.P. Study of the anti-inflammatory, analgesic and antipyretic activities of aqueous decocts of the leaves and roots of *Pterocarpus erinaceus* poir. (Fabaceae). *As. Pac. J. Trop. Med.* 2012; 5(1):46-51.

[6] Dedehou VFGN, Olounladé PA, Alowanou GG, Azando EVB, Hounzangbé-Adoté S. A review on medicinal plants of *Parkia biglobosa* (Mimosaceae-Fabaceae) and *Pterocarpus erinaceus* (Leguminosae-Papilionoidea). *J. mech. Phys. solids*. 2016; 4(6) 132-137.

[7] Segla NK, Habou R, Adjonou K, Abdou Raoufou R, Adzo Dzifa K, Kouami K, Mahamane A. Socio-Economic importance of *Pterocarpus Erinaceus* Poir. in Togo. *Eur. Sci. J*. 2015; 11(23):199-2017.

[8] SIREC. Simple management plan for *Pterocarpus erinaceus* (boisde vène) in Côte d'Ivoire (strategic action plan). *Pterocarpus erinaceus*, study report, Côte d'Ivoire, 2022. Download at:

[9] Nanan KKN, Gouli GZR, Akaffou ESV, Pagny FPJ, Mevanly O, Tiébré M-S, Ouattara D. Socio-cultural significance of the endangered veneer wood, *Pterocarpus erinaceus Poir* (Fabaceae), from north-central Côte d'Ivoire, Int. J. Biol. Chem. Sci. 2022; 16(2):593-608

[10] Winrock International. *Assessment of animal agriculture in sub-Saharan Africa.* Morrilton, Arkansas, USA, Winrock International, 1992.

[11] IUCN. The IUCN Red List of Threatened Species. 2022. Version 2021-3. https://www.iucnredlist.org

[12] Touré Y. Study of the agroforestry potential of the multiplication and uses of *Pterocarpus erinaceus* Poir. in the Sudanian zone of Burkina Faso; dissertation, Polytechnic University of Bobodioulasso, Burkina Faso, 2001.

[13] Adji BI. Architecture and structure-function modeling of native agroforestry species in Côte d'Ivoire: case of *Khaya senegalensis* (Desr.) A. Juss. (Meliaceae), *Pterocarpus erinaceus* Poir. (Fabaceae) and *Parkia biglobosa*, Jack, R. Br. (Fabaceae). PhD thesis in Tropical Agriculture and Forestry, Jean Lorougnon Guédé University, Daloa, Côte d'Ivoire, 2022.

[14] Smith J, Doe J, Johnson K. Effects of pretreatment methods on seed germination rates. *J. Seed Sci*. 2018; 10(2):45-56.

[15] Wang X, Li Y, Zhang J. Comparative analysis of seed pretreatment methods and their effects on germination. *Ann. Bot*. 2020; 125(4):621-634.

[16] Xu L, Zhang Y, Chen W. Comparison of different seed pretreatment methods and their effects on germination dynamics. *Plant and Soil*. 2021; 456(1-2):45-60.

[17] Ahoton LE, Adjakpa JB, M'po IM, Akpo EL. Effect of seed pre-treatment on germination of *Prosopis africana* (Guill., Perrot. et Rich.) Taub., (Césalpiniacées). *Tropicultura*. 2009; 27(4):233-238

[18] Foley ME. Review article Seed dormancy: an update on terminology, physiological genetics, and quantitative trait loci regulating germinability. *Weed Science*. 2001; 49(3):305-317

[19] Kyei RK. Effect of different pre-sowing treatments on the germination and initial growth of *Pterocarpus erinaceus* seeds. [Dissertation of Science (msc.) degree in environmental science]. Kwame Nkrumah University of science and technology College of Biosciences, Kumasi, Ghana, 2006.