

**SEED GERMINATION OF *TETRAPLEURA TETRAPTERA* AND  
*ENTANDROPHRAGMA CYLINDRICUM* SEEDS USING DIFFERENT PRE-  
TREATMENT METHODS**

**BY**

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**SR/2268/RPR/25/10**

**DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY**

**FACULTY OF LIFE SCIENCES**

**UNIVERSITY OF BENIN**

**BENIN CITY**

**EDO STATE.**

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT  
BIOLOGY AND BIOTECHNOLOGY, IN THE FACULTY OF LIFE  
SCIENCES OF UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL  
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BACHELOR OF SCIENCE (HONOURS) DEGREE (B.Sc.) IN PLANT  
BIOLOGY AND BIOTECHNOLOGY.**

**OCTOBER, 2025**

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Prof. B. Ikhajiagbe

Head of Department

## **DEDICATION**

This project is dedicated to Almighty God for his unwavering grace and mercy over me and to my parents for their support.

## **ACKNOWLEDGEMENTS**

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## ABSTRACT

Germination is the process through which a seed begins to grow and develop into a new plant, driven by the embryo's ability to restart its metabolic activities within the seed. *Tetrapleura tetraptera*, commonly known as Aridan fruit, is a medicinal plant found mainly in the lowland forests of tropical Africa, while *Entandrophragma cylindricum*, known as the Sapele tree, is a prized timber species that grows widely across the same region. Both trees serve many purposes as they are valuable sources of medicine for treating various ailments and are also used for firewood, charcoal, and timber production. This study investigated how different pre-treatment methods affect the germination of *T. tetraptera* and *E. cylindricum* seeds to find effective ways of overcoming seed dormancy and improving seedling production for reforestation and conservation. Seeds from both species were exposed to various scarification methods, including acid treatment with hydrochloric acid, dry heat, hot water, and mechanical rubbing with sandpaper, while untreated seeds served as a control. The treated seeds were planted in bags and observed for several days. However, none of the seeds germinated, suggesting that they are highly dormant and resistant to the applied treatments. The results from this study highlight the need for more advanced dormancy-breaking techniques to improve the propagation success and ensure the conservation of these forest trees, which are gradually declining due to deforestation and overexploitation.



# CHAPTER ONE

## 1.0 INTRODUCTION

Forests are among the most vital ecosystems on Earth, providing a wide range of services that are essential to human well-being. Although they occupy only about 30% of the planet's surface, forests are remarkably rich in life, sheltering around 60,000 tree species, 80% of known amphibians, 75% of bird species, and 68% of all mammals. Beyond their role in conserving biodiversity, which remains their most valued function, forests and their resources play a vital role in meeting human needs like providing timber and poles for construction, food, medicinal plants, raw materials for industries, cultural artifacts, and fodder for livestock. Forests are also essential for sustaining life, serving as a major source of oxygen through the absorption of carbon dioxide and its conversion during photosynthesis (Hilton-Taylor, 2009; Oboho, 2014).

The need for urbanization of humans has influenced deforestation of most forest vegetation, which has led to the loss of habitats of organisms that dwell in the forest, and most of these trees have slow growth rates, which causes their maturation to take several years which discourages individuals from planting them because they might not provide economic benefits quickly (FAO,2020).

By the late 19th Century, Nigeria had about 65 million hectares of rich tropical primary forests, with abundant flora and fauna. Now in the 21st Century, this area has been reduced to about 4 million hectares (Oloyode,2008). Another study conducted by the Nigerian Environmental Study/Action Team (NEST) showed that Nigeria lost five percent of its forest annually throughout the 1980s. Another report by Forestry Research Management, Evaluation and Coordination Unit (FORMECU) of the Federal Department of Forestry indicated that Nigeria still loses an average

of 350,000 hectares of forest cover annually. From a global perspective, Nigeria is rated highest in terms of deforestation, considering its large population and its economy is based extensively on land-based agriculture and the extraction of natural resources (Ogbonaya, 2003; Isichei, 2010).

Afforestation refers to the deliberate process of transforming land that has remained without forest cover for at least 50 years into a forested area. It serves as a resolution for alleviating the effects of deforestation by providing numerous benefits, which include addressing environmental degradation, more especially desertification, deforestation, erosion, and flooding, as well as reducing the effects of climate change. Most indigenous trees in Nigeria, such as *Milicia excelsa* (Iroko tree), *Entandrophragma spp* (Sapele tree), *Khaya senegalensis* (African mahogany), are highly exploited for their quality timber, and they are severely threatened and almost extinct (Onefeli and Adesoye, 2014).

The ecological, medicinal, and cultural significance of these plants makes them priceless. We can restore and safeguard these species in areas where they have been eradicated through reforestation. Afforestation, which involves planting of native trees in controlled environments, creates an opportunity where these species can flourish and recover, guaranteeing their existence for future generations (Abiodun et al,2012)

Different factors are necessary for the successful germination of their seeds. This is frequently dependent on the specific seed variety and is intimately related to the biological circumstances of the native habitat of a plant. The purpose of scarification treatments is to overcome seed dormancy and difficulty in germination of plant seeds. Scarification refers to any method used to make the seed coat more permeable to water and gases, thereby promoting seed germination. It involves weakening, breaking, or modifying the seed coat to enable the embryo inside to begin the

germination process. Scarification ensures that indigenous species can successfully regenerate in degraded and challenging environments (Priyadharshini and Lekha, 2021).

## **1.1 SEED GERMINATION**

Germination is the process by which seeds develop into new plants and is propelled by the plant embryo's capacity to sequentially resume its metabolic activity while implanted in the seed. It is the process of growth and development of the embryo, which is active after imbibition (Bewley and Black, 1994).

Imbibition is the mechanism by which the seed absorbs water when there is an adequate supply of water. Certain enzymes are activated by the water, starting the seed development process. The seed first develops a root to gain access to underground water. The growth above the earth, or shoots, then start to emerge. It will grow leaves there to obtain energy from the light. Through a process known as photomorphogenesis, the leaves keep growing in the direction of the light source (Bradford, 1995).

### **1.1.1 Factors Influencing Seed Germination in Plants**

A number of internal and external factors affect seed germination. Imbibition is triggered by enough water, softening the seed coat and triggering the release of nutrients through enzymes. While improper aeration slows down germination, oxygen is necessary for respiration. The rate and success of growth are influenced by temperature, and different plant species react differently to light. Pathogens can lower survival rates by attacking seeds and seedlings. Internal factors that affect effective germination include hormones, stored food, dormancy, and seed viability. It is essential to comprehend and adjust these elements in order to maximize tree seedling germination (Manish et al, 2024).

### **1.1.2 The need for seed pre-treatments**

Strategic pre-treatment of seeds is essential to effective nursery management, especially for seeds with a germination period longer than one week. This proactive strategy lowers the use of resources while also saving time. When working with species like mango and mahogany that are prone to twisted roots or shoots at emergence, germination tests are crucial to figuring out the best seed orientation for these seeds. Prioritizing the pre-treatment of seeds with extended germination times helps the nursery achieve faster production schedules. This helps farmers create planting schedules that coincide with the best planting times while also lowering nursery expenses (Manish et al,2024).

## **1.2 Controlling Germination**

Optimal germination conditions are essential for successful seed development. Maintaining consistent humidity around the seed is the primary factor in this process. Various coverings, including sieved soil, sand, rice hulls, or pine needles, may be used to retain moisture. Supplementary fertilizer should not be added to the substrate, as this practice increases the risk of diseases such as damping off (Kheloufi et al,2018).

When seedlings start to grow, they usually get all the nutrients they need from the cotyledons or, for palms, from the first leaf inside the seed. Because of this, using a substrate without fertilizer, such as sand, is often best for germination. However, small seedlings can easily be affected by damping-off, which is caused by fungi on the seed surface or in the substrate (Raphael et al,2023).

It is also important to understand that sterilizing the substrate might get rid of helpful bacteria, fungi, and insects. Some of these microbes are essential for decomposing organic materials or helping plants absorb nutrients. Sterilization practices need to be balanced to support a healthy germination environment (Ochieno,2022).

### 1.3 Seed Dormancy

Seed dormancy is one of the least known phenomena in the field of seed science; it can be simply defined as a barrier to the completion of germination of an intact viable seed under favorable conditions (Hilhorst, 1995; Bewley, 1997a).

When the seed is dormant, it cannot germinate within a given time frame under any combination of typical physical environmental conditions that would normally favor its germination; that is, after the seed is no longer latent (Baskin and Baskin, 2004).

#### Type of Seed Dormancies

**Physiological dormancy (PD):** Physiological dormancy is the predominant form of seed dormancy, present in gymnosperm seeds and all major angiosperm groups. It is the most common dormancy type found in temperate seed banks and the most widespread in natural field conditions. Additionally, PD is the primary dormancy mechanism observed in laboratory studies of key seed model species, such as *Acer platanoides*, *Acer pseudoplatanus*, *Lactuca sativa*, *Lycopersicon esculentum*, *Nicotiana spp*, *Avena fatua*, and various cereals (Baskin and Baskin, 2004).

**Morphological dormancy (MD):** MD occurs in seeds with embryos that are underdeveloped in size yet differentiated, featuring structures like cotyledons and the hypocotyl-radicle. These embryos lack physiological dormancy but require additional time to mature and germinate. A prime example is *Apium graveolens* (Jacobsen and Pressman, 1979).

**Morphophysiological dormancy (MPD):** This involves seeds with underdeveloped embryos that also exhibit a physiological dormancy component. This dual mechanism distinguishes MPD, which manifests in eight recognized levels of complexity. A notable example is *Fraxinus excelsior* (Finch-Savage and Leubner-Metzger, 2006).

**Physical dormancy (PY):** This arises from water-impermeable layers of palisade cells in the seed or fruit coat that restrict water movement, preventing germination. This dormancy can be overcome through mechanical or chemical scarification. Notable examples include *Melilotus* and *Trigonella* (Finch-Savage and Leubner-Metzger, 2006).

**Combinational dormancy (PY + PD):** Combinational dormancy occurs in seeds with water-impermeable coats, characterized by a combination of physical dormancy and physiological embryo dormancy. Notable examples include *Geranium* and *Trifolium* (Baskin and Baskin 2004).

To promote germination in seeds with tough, water-resistant coats, various techniques are used, such as mechanical or chemical scarification and soaking in hot or boiling water. For seeds with permeable coats, treatments like cold stratification, gibberellic acid (GA3), sodium hypochlorite, scarification, or heat application can be effective. While some seeds naturally break dormancy over time, others require specific pre-sowing treatments. Seed dormancy presents a significant challenge to successful germination, often requiring methods like mechanical or acid scarification, hot or cold-water soaking, chemical or growth regulator applications, or alternating wet and dry cycles to effectively overcome it (Baskin and Baskin,2020).

1. **Breaking Seed-Coat Dormancy:** Preferred ways for breaking seed-coat dormancy include gently abrading the seed with a knife, needle, or sandpaper, or piercing, nicking, chipping, or otherwise breaking through the resistant outer coating (Gunaga et al,2011).
2. **Breaking Embryo Dormancy:** There are several recommended methods for breaking embryo dormancy.
  - a) **Cold Stratification:** Seeds are first placed in containers filled with a damp germination medium and stored in a refrigerator at 3–5 °C for about 7 to 14 days. However, species that originate from colder regions—especially perennials adapted to long periods of snow and

harsh winters—require much lower temperatures and longer exposure times to achieve successful stratification. For example, a perennial herb native to mountainous areas with prolonged cold seasons showed improved germination when subjected to extended chilling. When the seeds were kept at 0 °C (32 °F) for seven months, the germination rate significantly increased, reaching about 60% (Cuenca-Lombraña *et al*,2018).

- b) **Hormonal Treatments:** Seed dormancy can be overcome through the application of certain plant hormones such as abscisic acid (ABA), gibberellic acid (GA<sub>3</sub>), ethylene, and jasmonic acid (JA). Among these, gibberellic acid (GA<sub>3</sub>) is recognized as the most effective in triggering germination. In germination tests, the seeds are usually placed on moist paper treated with a 0.05% GA<sub>3</sub> solution, which is prepared by dissolving 500 mg of GA<sub>3</sub> in one liter of water. The action of GA<sub>3</sub> works by softening the endosperm, stimulating embryo growth, and enabling the seedling to push through the seed coat (Shu *et al*,2016).
- c) **Chemical Scarification:** Seed coat impermeability often limits water uptake, making germination difficult, particularly in tree species from dry and semi-arid regions. One effective way to address this barrier is through chemical scarification. By exposing seeds to certain chemicals, dormancy can be broken, allowing water to penetrate and germination to proceed. Treatments may involve acids, bases, organic solvents, alcohol, disinfectants, or even hot water. Among the commonly used acids are phosphoric acid (25–75% depending on the species), nitric acid, potassium nitrate, and concentrated sulphuric acid (96%) (Kheloufi *et al*,2018).
- d) **Light Treatment:** Exposing seeds to strong cool-white and infrared light helps recreate the natural conditions of spring and summer. For effectiveness, the light source should be placed close to the seeds and kept on for at least eight hours a day in a moist setting at low

temperatures. Once this light treatment is complete, the seeds are then moved to darkness for incubation until germination occurs (Olatunji *et al*,2013).

The influence of light differs depending on seed size. In most cases, medium and large seeds are neutral photoblastic, meaning they can germinate equally well in light or dark conditions. For these seeds, germination is mainly controlled by soil moisture and temperature, while light plays only a minor role (Goggin *et al*,2011).

- e) **Cold or Hot Water:** This approach is both cost-effective and practical for farmers, making it a valuable method for boosting seed germination. When applied to most medium-sized dry seeds, the treatment enhances germination by ensuring the seeds take up sufficient water and by softening their seed coats. While heat treatment can moderately help in breaking dormancy, the study highlights that acid scarification for 1–30 minutes and heat exposure at 55–77 °C for about an hour are effective for optimizing germination, depending on the species. Additionally, soaking seeds in water for 24–48 hours help to soften tough seed coats and remove chemical inhibitors that may otherwise hinder germination (Umarani and Vanangamudi,2005).
- f) **The warm and/or cold stratification:** Stratification is a method used to weaken the tough outer layer of seeds to encourage germination. It works by placing the seeds in a moist environment, which gradually softens the seed coat and allows the embryo to emerge more easily. This process can be carried out in two ways, either through cold stratification or warm stratification (D'Este *et al*,2019).
- g) **Scarification:** Scarification is a technique used to encourage seed germination by breaking down or softening the tough outer seed coat. It works by physically altering the seed covering through methods like scratching, nicking, or rubbing with sandpaper or a file so

that water and air can penetrate. This method is especially useful for seeds with hard shells that would otherwise block moisture and oxygen from reaching the embryo (D'Este *et al.*,2019).

#### **1.4 Example of Seed Pre-Treatment for Improved Germination**

**Soaking in Cold Water:** Pre-soaking seeds in cold water for 24 to 48 hours before planting has been identified as a useful pre-germination technique. Research by Hossain *et al.* (2005) reported that *Terminalia chebula* seeds achieved a germination rate of 66.7% after 48 hours of cold-water treatment, which further improved to 73% when the seeds were de-pulped before soaking. Similarly, findings by Burrows *et al.* (2009) on *Terminalia paniculata* Roth confirmed that immersing seeds in water for 24 hours significantly enhanced germination.

**Soaking in Hot Water:** For seeds with tough or impermeable coats, soaking in hot water has proven to be an effective way to enhance germination. This method is commonly used for species with hard shells such as *Albizia*, *Acacia*, *Cassia*, poplars, and *Leucaena leucocephala* (Lam.) de Wit. The process typically involves immersing the seeds in hot water for a period ranging from 2 to 48 hours, depending on the species. Compared to traditional treatments like sulphuric acid, hot water soaking is viewed as a safer, more economical, and environmentally friendly option. Remarkably, Subabul seeds treated with hot water for 12 hours recorded a germination rate of 42.22%, highlighting the effectiveness of this technique (Hamad and Anwer,2021).

**Alternate Wetting and Drying:** This approach have been shown to work particularly well for seeds with hard or thick seed coats. Research by Gupta and Pathanath. (1975) revealed that while teak seeds from some regions germinate without any treatment, others respond better when

exposed to cycles of wetting and drying. In line with this, Pamei et al. (2017) reported that *Tectona grandis* (L.f.) seeds treated with alternating periods of wetting (12 hours) and drying (12 hours) over eight days achieved the highest germination rate (43.3%) and also produced seedlings with superior height and root development.

**Nicking and Sand Paper Scarification (Mechanical):** Mechanical methods are highly effective in breaking the tough, water-resistant seed coats found in species such as *Acacia catechu* (L.f.) P.J.H. Hurter & Mabb, *A. nilotica* (L.f.) P.J.H. Hurter & Mabb, *Albizia* spp., and *Cassia fistula* L. Studies have shown that slightly nicking the distal end of *Gliricidia sepium* seeds improves germination while keeping the embryo intact. Similarly, scarifying the seeds of *Melia azedarach* (Jacq.) Steud and *Acacia auriculiformis* A. Cunn. Ex Benth with sandpaper produced remarkable germination rates of 80% and 78%, respectively. Manual seed cutting has also proven successful, yielding 100% germination in *Prosopis juliflora* (Sw) DC. and 90.4% in *Dalbergia sissoo* Roxb (Asif et al,2020).

**Acid Scarification:** Treating seeds with concentrated sulphuric acid is a widely used technique to break seed coat hardness. The acid works by corroding the outer layers of the coat and opening up the lumens of macrosclereid cells, which makes it easier for the seeds to absorb water. For example, *Semecarpus anacardium* L.f. seeds exposed to 98% H<sub>2</sub>SO<sub>4</sub> for just one minute showed the highest germination rate of 74.67%. Similarly, Olatunji et al. (2013) observed that *Acacia auriculiformis* A. Cunn. Ex Benth seeds treated with concentrated H<sub>2</sub>SO<sub>4</sub> for 5–10 minutes achieved excellent germination levels ranging between 92–96%. Furthermore, germination can also be promoted in seeds with hard, impermeable coats by the oxidation of phenolic compounds using agents such as hypochlorite or hydrogen peroxide, or by reducing polyphenol oxidase activity (Gendreau and Corbinau, 2009).

**Seed Priming Treatments:** Seed priming is a pre-sowing technique where seeds are partially hydrated to trigger early metabolic activity without allowing the radicle to emerge. This method has shown clear benefits for the germination of various tropical tree species, including *Albizia saman* (Jacq.) Merr, *Cedrela odorata* L., and *Swietenia macrophylla* King. Similarly, hydropriming has been reported to enhance the germination performance of *Enterolobium cyclocarpum* (Jacq.) Griseb. In addition, inoculating *Acacia senegal* (L.) Willd. seeds with rhizobium have also yielded positive outcomes for seed germination (Singh *et al*, 2011).

### **1.5 How plant hormones regulate germination**

Plant growth regulators are central to the process of seed germination, with hormones such as gibberellins (GA), abscisic acid (ABA), auxins, and ethylene exerting strong regulatory effects. Ethylene, in particular, is thought to play an important role in overcoming dormancy by interacting with GA metabolism. Research has shown that treating seeds with GA solutions can boost germination traits, leading to stronger seed vigor and more uniform sprouting. Furthermore, the combined use of regulators like GA<sub>3</sub>, IAA, and IBA, together with cold stratification, has proven effective in breaking dormancy and improving germination across a range of plant species (Dhiman *et al*, 2015).

## 1.6 Aims and Objectives

The aims of this project are as follows:

- To determine how different seed pre-treatments affect the germination rate of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* seeds
- To determine which seed pre-treatment best overcomes seed dormancy in *Tetrapleura tetraptera* and *Entandrophragma cylindricum* seeds
- To improve seedling production for forest regeneration purposes
- To be able to germinate forest trees irrespective of the environment they can survive in

The objective is to address the following hypothesis:

- Do seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* species readily germinate under ideal moisture and temperature conditions?
- Do seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* species enter a state of dormancy that prevents spontaneous germination until treated with a particular scarification intervention?
- Does acid scarification enhance the germination of seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* species?
- Will hot water scarification improve the germination of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* compared to untreated ones?

This study is done to assess the seed characteristics of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* and to determine the most effective scarification method for ensuring fast, reliable, and successful germination.

### **1.7 *Tetrapleura tetraptera* (Schumach. & Thonn.) Taub.**

*Tetrapleura tetraptera*, popularly called Aridan fruit, is a medicinal plant belonging to the Mimosaceae family. It thrives mainly in the lowland forests of tropical Africa. In Nigeria, it is widely distributed, particularly across the southeastern states such as Abia, Imo, Anambra, Enugu, and Ebonyi, and can also be found in parts of the northern region, including Kano, Kaduna, Taraba, and Katsina. The fruit is quite striking, often hanging firmly at the tips of branches on thick stalks about 25 cm long. It is smooth, glossy, and dark purple-brown in color, typically measuring 15–25 cm in length and about 5 cm in width, with a slightly curved shape. Its most distinctive feature is the four longitudinal wing-like ridges, each about 2 cm broad. While two of these wings are hard and woody, the other two contain a sweet, aromatic pulp that is rich in oil and has a pleasant fragrance. The tree sheds its fruits in December, while flowering starts by late February and continues until early April (Ogbuagu and Chinagorom,2015).

The plant is valued for its wide range of uses, spanning from food to cosmetics. Traditionally, it is given to mothers in the postpartum period, as it is believed to ease recovery by preventing contractions and supporting milk production. In many West African countries, the fruits are commonly incorporated into local seasonings, used in soups, or blended into pomades as a dietary supplement. In Ghana, the fruits, seeds, and flowers also serve as key ingredients in perfumes, alcoholic drinks, and even as flavoring agents in biscuits (Anyamele et al,2023).

The rich composition of phytochemicals and other bioactive compounds in *Tetrapleura tetraptera* endows its extracts with significant biological activities that underpin its widespread use in traditional medicine. Research has shown that these extracts exhibit a wide range of therapeutic properties, including antimicrobial effects (such as antifungal and antibacterial actions), strong antioxidant activity, and anti-inflammatory potential. They are also reported to possess anti-

diabetic, antiparasitic (anti-trypanosomal, anti-helminthic, and molluscicidal), antiproliferative (anticancer), antiprotozoal (notably antimalarial), and antiviral properties (Anyamele et al,2023).

Another use of *Tetrapleura tetraptera* is its wound-healing properties. According to Tsala *et al* (2014), the stem bark extract was evaluated. Results revealed that when applied topically, the extract significantly enhanced the recovery of both excision and incision wounds in rats. The findings highlight the strong therapeutic promise of the stem bark in skin repair, likely through mechanisms involving accelerated epithelialization, improved wound contraction, and increased tensile strength.

#### **Taxonomy of *Tetrapleura tetraptera***

Kingdom: Plantae

Division: Tracheophyta

Class: Magnoliopsida

Order: Fabales

Family: Fabaceae

Subfamily: Mimosoideae

Genus: *Tetrapleura*

Species: *Tetrapleura tetraptera*



**Plate 1.1: *Tetrapleura tetraptera* tree**

### **1.8 *Entandrophragma cylindricum* (Sprague) Sprague**

*Entandrophragma cylindricum*, commonly known as the Sapele tree, is a highly valued timber species that thrives across tropical Africa, ranging from Sierra Leone to Uganda and the Democratic Republic of the Congo. In Uganda, it is commonly found in mixed and climax tropical rainforests, as well as in thickets and gallery forests such as Budongo, Bugoma, Mabira, and West Mengo. The tree is prized for its wide range of uses, including firewood, charcoal, timber for furniture, veneer, shade, and as an ornamental species for avenues (Grubben,2008).

*Entandrophragma cylindricum* is a tall deciduous forest tree that can reach heights of 55 meters or more. Its trunk is usually straight and slender, often clear of branches for 25–30 meters, supporting a medium-sized, rounded crown. The tree develops prominent buttresses that may rise up to 3 meters, and the trunk can exceed a meter in diameter. The bark starts smooth and brown but gradually turns grey with age, shedding in irregular scales near the base. Its leaves are pinnate, arranged in tufts at the tips of branches, and may reach 30 cm in length. Each leaf carries 11–19 leaflets, typically alternating in position. The lower pairs are oval, while the upper ones are longer and more narrowly oval, measuring up to 12 cm with pointed tips. Both surfaces show 6–9 lateral veins and a fine network of smaller veins.

The flowers are small and white, borne on branched stalks up to 25 cm long. The fruit is a woody, brown capsule about 14 cm long, rounded at the tip, which splits into five sections. It opens first at the tip and later at the base, releasing the parts gradually. Inside, winged seeds about 8 cm long are attached alternately on either side of the central column. The winged seeds are carried several meters away from the parent tree by the wind, making collection challenging since each seed must be gathered individually from the ground (Grubben,2008).

The wood has a rich brown color and a pleasant fragrance. It is denser, stronger, harder, and longer-lasting than mahogany, although it is less easy to work with. Classified as a premium timber, it is widely prized for both indoor and outdoor furniture as well as for producing fine veneers. For decades, it has served as an important export product from West Africa (Grubben,2008).

**Taxonomy of *Entandrophragma Cylindricum***

Kingdom: Plantae

Division: Tracheophyta

Sub-division: Angiosperm

Class: Eudicots

Order: Sapindales

Family: Meliaceae

Genus: *Entandrophragma*

Species: *Entandrophragma cylindricum*



**Plate 1.2:** *Entandrophragma cylindricum* seeds

## CHAPTER TWO

### MATERIALS AND METHODOLOGY

#### 2.1 The study area description

The study was carried out in 2025 at the Screen House of the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State.



**Plate 2.1: The screen house, Department of Plant biology and Biotechnology, University of Benin, Benin city, Edo State.**

## **2.2 Source of seed samples**

Seeds of *Tetrapleura tetraptera* were collected on August 27, 2025 from the Faculty of Social Sciences, University of Benin, Benin City, Edo State, while those of *Entandrophragma cylindricum* were provided by Prof. Aigbokhan.

## **2.3 Preparation of collected seeds**

Seeds of *Tetrapleura tetraptera* were carefully extracted from their pods and dried in the shade for 24 hours. For *Entandrophragma cylindricum*, the seed wings were detached, after which the seeds were air-dried for three days before being stored in a cool, dry place.

## **2.4 Materials**

In the course of this study, a variety of materials were utilized. Planting bags were first obtained, labeled with paper tape, and prepared for sowing the seeds. Mechanical scarification was carried out using sandpaper by gently brushing the seeds across its surface. Hydrochloric acid (HCl) was employed for acid stratification, while both a candle and hot water were applied for dry heat and hot water scarification, respectively. Suitable soil was also sourced to provide a conducive medium for seed growth. Regular watering was ensured to maintain proper hydration throughout the experiment. Additional materials used included markers, a conical flask, a hand trowel, a sieve, and a bowl, among others.

## **2.5 Overcoming Seed Dormancy**

The experiment followed a completely randomized design, with each scarification treatment replicated three times.

- i. Sci 1 = Nicking (Mechanical treatment)
- ii. Sci 2 = Hot water
- iii. Sci 3 = Control (No treatment)

- iv. Sci 4 = Acid treatment (Scarification with hydrochloric acid)
- v. Sci 5 = Dry heat (Scarification by heating)

## 2.6 Experimental Methodology

The seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* were surface-sterilized with a 10% Jik solution prepared in 250 ml of water, before performing each treatment.

The experiment involved five different scarification treatments: acid, dry heat, mechanical, hot water, and control.

- i. **Dry heat treatments:** The seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* were fried in a pan for 5 minutes and 10 minutes, respectively.
- ii. **Nicking treatment (Mechanical):** The seeds of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* were gently brushed over the surface of sandpaper for few seconds and planted immediately.
- iii. **Hot water treatment:** Seeds were soaked in hot water for 5 minutes and 10 minutes, respectively.
- iv. **Acid treatment:** The seeds were soaked in concentrated hydrochloric acid for 3 minutes and 6 minutes, respectively.
- v. **Control:** No treatment was done on the seeds.

Seeds subjected to acid treatment were carefully rinsed in clean water to remove any acid residue, then air-dried on A4 paper before being planted in soil-filled bags, and the bags were arranged in a randomized layout. Each treatment was replicated three times to ensure the accuracy and reliability of the results.

## 2.7 Statistical Analysis

The germination percentage of the seeds was calculated by counting the germinated seedlings and using the following formula.

$$\text{Seed germination \%} = \text{Number of seedlings emerged} / \text{Total number of seeds sown} * 100$$



**Plate 2.2: Dry heat Scarification of *Tetrapleura tetraptera* seeds**



**Plate 2.3: Hot water Scarification on *Entandrophragma cylindricum* seeds**



**Plate 2.4: Randomized arrangement of planting bags**

## **CHAPTER THREE**

### **RESULTS**

This experiment indicates the number of positive germinations in all the germination treatments tested of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* seeds. The results of the experiments on the germination response of *Tetrapleura tetraptera* seeds are shown in Table 1.

**Table 1: Germination of *Tetrapleura Tetraptera***

<b>SCARIFICATION</b>	<b>NUMBER OF SEEDS SOWN</b>	<b>NUMBER OF GERMINATED SEEDS</b>	<b>GERMINATION PERCENTAGE (%)</b>
SC1R1	3	0	0.00
SC1R2	3	0	0.00
SC1R3	3	0	0.00
SC2R1	3	0	0.00
SC2R2	3	0	0.00
SC2R3	3	0	0.00
SC3R1	3	0	0.00
SC3R2	3	0	0.00
SC3R3	3	0	0.00
SC4R1	3	0	0.00
SC4R2	3	0	0.00
SC4R3	3	0	0.00
SC5R1	3	0	0.00
SC5R2	3	0	0.00
SC5R3	3	0	0.00

**KEY**

SC1: Mechanical scarification using sandpaper, SC2: Hot water treatment, SC3: Acid treatment using Hydrochloric acid (96%), SC4: Dry heat treatment, SC5: Control, R1: First replicate, R2: Second replicate, R3: Third replicate

The results of the experiments on the germination response of *Entandrophragma cylindricum* seeds are shown in Table 2.

**Table 2: Germination of *Entandrophragma cylindricum***

SCARIFICATION	NUMBER OF SEEDS SOWN	NUMBER OF GERMINATED SEEDS	GERMINATION PERCENTAGE (%)
SC1R1	4	0	0.00
SC1R2	4	0	0.00
SC1R3	4	0	0.00
SC2R1	4	0	0.00
SC2R2	4	0	0.00
SC2R3	4	0	0.00
SC3R1	4	0	0.00
SC3R2	4	0	0.00
SC3R3	4	0	0.00
SC4R1	4	0	0.00
SC4R2	4	0	0.00
SC4R3	4	0	0.00
SC5R1	4	0	0.00
SC5R2	4	0	0.00
SC5R3	4	0	0.00

**KEY**

SC1: Hot water treatment, SC2: Dry heat treatment, SC3: Mechanical scarification using sandpaper, SC4: Acid treatment using Hydrochloric acid, SC5: Control, R1: First replicate, R2: Second replicate, R3: Third replicate

## CHAPTER FOUR

### DISCUSSION

The results of these experiments revealed that none of the scarification methods or control used resulted in the successful germination of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* seeds within the study period. The non-germination of the seeds indicates that the seeds tested are particularly difficult to germinate, as the methods employed were ineffective in breaking the seed dormancy characteristics of these species. This experiment was likewise conducted on other seed species, including *Omphalocarpum procerum* P. Beauv., *Chrysophyllum albidum* G. Don., and *Treculia africana* Decne. ex Trécul. The results also showed that these seeds also failed to germinate successfully. This also indicates the difficulty in the germination of the seeds as the scarification methods used were unable to break the seed dormancy of the species

The absence of germination in both *Tetrapleura tetraptera* and *Entandrophragma cylindricum* suggests the presence of a strong form of seed dormancy, possibly physical or physiological in nature. According to Bewley et al. (2013), many tropical tree species possess hard, impermeable seed coats that prevent water absorption and gas exchange, thereby delaying or completely inhibiting germination. The seeds of *Tetrapleura tetraptera* are known to have exceptionally tough seed coats composed of lignified layers that restrict water uptake (Esenowo and Akinyemiju, 2010). Similarly, *Entandrophragma cylindricum* seeds, which belong to the family Meliaceae, have been reported to exhibit recalcitrant seed behavior, meaning they lose viability rapidly and are sensitive to desiccation. This could explain the total lack of germination observed after the treatments (Orwa et al., 2009).

Although pre-treatments such as acid scarification and hot water immersion are often effective in weakening seed coats and enhancing germination in hard-seeded species, the present findings suggest that the duration or concentration of treatments applied may not have been adequate to break dormancy in these species. Hydrochloric acid, for example, is effective only when exposure time and concentration are optimized; excessive treatment can damage the embryo, while mild exposure may not sufficiently weaken the seed coat. The mechanical scarification with sandpaper also showed no improvement, which may indicate that the seed coat thickness exceeded the degree of abrasion applied (Nandi et al., 2020).

For *Entandrophragma cylindricum*, the dry heat and hot water treatments also failed to stimulate germination, suggesting that the seeds may have lost viability before the experiment. Seed viability is a critical factor influencing germination success, and recalcitrant seeds, such as those of *E. cylindricum*, often lose viability within a few weeks of harvest if not properly stored (Hong and Ellis, 1996). This aligns with the observations of Schmidt (2000), who reported that *Entandrophragma* species show low germination rates under laboratory conditions unless freshly collected and sown immediately after extraction from the fruit.

The absence of germination across all treatments may also be attributed to combined dormancy mechanisms, where both the seed coat and physiological factors interact to inhibit germination. Studies by Baskin and Baskin (2014) demonstrated that some tropical hardwood species require combined mechanical and chemical treatments, or a period of moist chilling (stratification) to break dormancy effectively. Therefore, a combination of scarification and hormonal treatments (such as gibberellic acid application) could be more effective in promoting germination in subsequent experiments.

In general, the findings highlight the complex dormancy nature of both *Tetrapleura tetraptera* and *Entandrophragma cylindricum*, emphasizing the need for more refined and species-specific pre-treatment protocols. Understanding the dormancy physiology of these species is crucial for their conservation, propagation, and sustainable utilization in forestry and agroforestry systems. Further studies should explore longer acid exposure times, enzymatic softening, or growth regulator applications to enhance germination success.

## CONCLUSION

This study investigated the germination responses of *Tetrapleura tetraptera* and *Entandrophragma cylindricum* seeds subjected to different pre-treatment methods. From the results, there was no germination across all treatments, which suggests that both species possess strong dormancy mechanisms that the seed pre-treatment methods could not overcome. The inability of *Tetrapleura tetraptera* seeds might be due to their extremely hard seed coat, while *Entandrophragma cylindricum* seeds may have lost viability due to their recalcitrant nature, and also the response to the severity of the different treatment methods.

These observations highlight the need for more species-compatible and advanced dormancy-breaking techniques, such as hormonal and seed priming treatments. The research emphasizes the complexity of forest tree seed dormancy and calls for further studies aimed at identifying effective germination procedures.

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