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Research Article

# Water Soaking Duration as a Dormancy-Breaking Strategy for Enhancing Germination of Decoated *Garcinia kola* (Heckel) Seeds

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## Abstract

Seed dormancy remains a critical bottleneck in the nursery propagation of *Garcinia kola* Heckel, a socioeconomically and medicinally important non-timber forest species of West and Central Africa. This study investigated the effect of varying water-soaking durations on dormancy alleviation and germination performance of decoated *G. kola* seeds under controlled nursery conditions. Freshly collected seeds were decoated and subjected to four pre-germination treatments: no soaking (T1, control), 24-hour soaking (T2), 48-hour soaking (T3), and 72-hour soaking (T4). A Completely Randomized Design (CRD) was employed with 10 seeds per tray and five replicates per treatment, sown in sterilized river sand. Germination onset was earliest in T4 (Week 5), followed by T3 (Week 6), T2 (Week 7), and T1 (Week 9). The highest cumulative germination percentage (CGP) was recorded in T4 (80%), compared with T3 (64%), T2 (56%), and T1 (38%). The complete dormancy period (CDP) ranged from 35 days (T4) to 63 days (T1), decreasing significantly with longer soaking duration. These results indicate that *G. kola* seeds exhibit both seed coat dormancy and chemically-imposed dormancy, and that 72-hour soaking of decoated seeds is an effective, low-cost, and farmer-accessible method for hastening germination onset and improving seedling yield.

## Keywords

Garcinia Kola, Seed Dormancy, Pre-germination Soaking, Cumulative Germination Percentage, Non-timber Forest Products, Tropical Nursery Propagation

## 1. Introduction

Forest tree species represent an invaluable source of medicinal compounds, nutritional products, and livelihood resources for rural communities across the tropics. The bark, leaves, fruits, roots, and seeds of these species are widely utilized in traditional medicine to treat various diseases, and their commercial exploitation constitutes a significant driver of rural economic empowerment [7, 8, 13, 30]. Among the most economically and pharmacologically significant of these species is *Garcinia kola* Heckel (Guttiferae), a medium-sized tree reaching up to 12 m in height, naturally distributed across the moist forests of West and Central Africa [16, 24].

The seed of *G. kola*, commonly referred to as bitter kola in Cameroon, is a non-timber forest product (NTFP) of considerable socioeconomic relevance [22]. It serves as a bitter stimulant [5] and has been documented to exhibit a broad spectrum

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of pharmacological properties, including antimicrobial, antibacterial, anti-inflammatory, and antiviral activities [14, 27, 29]. Growing global demand from pharmaceutical, food, and confectionery industries has intensified pressure on wild populations of the species, yet its successful cultivation remains constrained by persistent challenges in seedling production [6, 18].

The primary obstacle to *G. kola* propagation is pronounced seed dormancy, which can delay germination for up to 18 months under unmanaged conditions [25]. Seed dormancy in this species has been attributed to both physical resistances imposed by the seed coat and to the presence of germination-inhibiting chemical compounds within the seed embryo [1, 12]. Several dormancy-breaking strategies have been explored, including mechanical scarification, chemical treatments, and water soaking [4, 11, 21, 31]. However, many of these approaches require technical inputs or resources that may not be accessible to smallholder farmers.

Simple and scalable dormancy-breaking techniques suitable for adoption by farmers with low technological capacity are therefore urgently needed. Water soaking, owing to its low cost and simplicity, represents a particularly promising avenue for practical application. Nonetheless, the optimal soaking duration for maximizing germination efficiency in *G. kola* remains incompletely characterized. The present study was therefore designed to evaluate the effects of four water soaking durations on the germination performance of decoated *G. kola* seeds, with the objective of identifying an optimal presowing treatment to reduce dormancy and promote early, uniform germination.

## 2. Materials and Methods

### 2.1. Study Site

The experiment was conducted at the nursery of the Higher Institute of Environmental sciences (HIES), Cameroon (latitude 3° 51′ 54″ N; longitude 11° 27′ 39″ E). The site receives a mean annual rainfall of 1,605.13 mm distributed over approximately 90 rainy days per year. Mean maximum and minimum temperatures are 28.9°C and 22.2°C, respectively, with a mean relative humidity of 83.9% [17].

### 2.2. Seed Collection and Processing

Mature fruits of *Garcinia kola* were harvested from a single mother tree at Bamenda North-west region, Cameroon. Seeds were manually extracted from the fruit pulp, washed under running water, and air-dried at ambient temperature (below 25°C) for three days to facilitate coat removal. Seed coats were then removed manually prior to treatment application, as seeds with intact coats have been shown to yield significantly lower germination rates [2].

### 2.3. Experimental Design and Pre-germination Treatments

Two hundred (200) seeds of uniform size were selected and randomly allocated to four pre-germination soaking treatments:

1) T1 (Control): No soaking
2) T2: Soaking for 24 hours
3) T3: Soaking for 48 hours
4) T4: Soaking for 72 hours

Seeds assigned to T2, T3, and T4 were immersed in fresh water at 3°C. To minimize the accumulation of germination inhibitors during the soaking period, water was decanted and replaced every 24 hours. The seeds were then sown in germination trays filled with washed and autoclaved river sand to a uniform depth of 2 cm and placed in a propagation chamber maintained at high relative humidity, a low light intensity of 10%, and a temperature of 16°C. The chamber was protected from wind, heavy rainfall, pests, and disease. The experiment was arranged in a Completely Randomized Design (CRD), with 10 seeds per germination tray and five replicates per treatment (n = 50 seeds per treatment; 200 seeds total).

### 2.4. Data Collection and Statistical Analysis

Germination was defined as the visible emergence of the plumule above the sand surface. Germination counts were recorded weekly until no further germination was observed for four consecutive weeks. Two response variables were measured: (1) Cumulative Germination Percentage (CGP) and (2) Complete Dormancy Period (CDP), defined as the number of days from sowing to first germination.

CGP was calculated as:

$$CGP\ (\%) = (\Sigma n / N) \times 100$$

where $n$ is the number of seeds germinated at each weekly count and $N$ is the total number of seeds per treatment [20].

Mean Germination Time (MGT) was calculated following [15] as:

$$MGT\ (weeks) = \Sigma(n \times T) / \Sigma n$$

where $n$ is the number of seeds newly germinated at time $T$, and $T$ is the time in weeks from the beginning of the germination test. Data were analyzed using descriptive statistics and results are presented in tables and figures.

## 3. Results

### 3.1. Germination Mode and Onset

*Garcinia kola* seeds exhibited hypogeal germination across all treatments. Soaking duration exerted a pronounced effect on dormancy period and germination onset. Germination commenced earliest in T4 (Week 5), followed by T3 (Week 6), T2 (Week 7), and T1 (Week 9) (Figure 1). Seeds in T1 and T2 showed markedly delayed and sparse germination, while T3 and T4 exhibited earlier and more abundant germination.

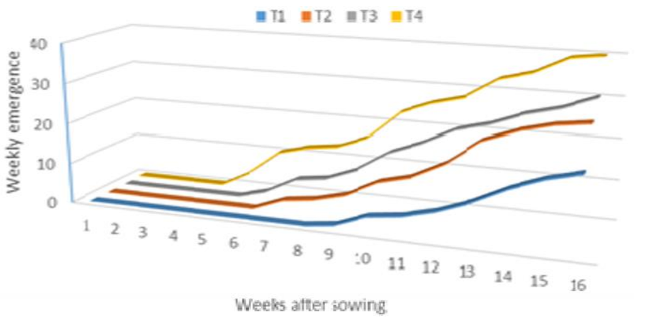


*Figure 1. Effect of soaking treatments on the cumulative germination of G. kola seeds.*

### 3.2. Cumulative Germination Percentage

Soaking duration significantly influenced CGP (Table 1). T4 recorded the highest CGP (80%), followed by T3 (64%), T2 (56%), and T1 (38%). A consistent positive relationship was observed between soaking duration and cumulative germination percentage, with mean germination values increasing progressively from T1 through T4 (Figure 2).

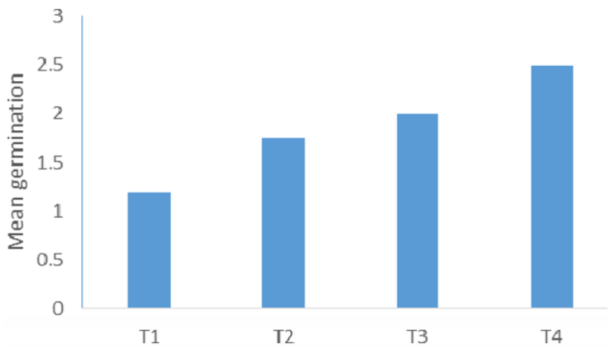


*Figure 2. Mean germination value for the different treatments.*

*Table 1. Effect of water soaking duration on the Cumulative Germination Percentage (CGP) of decoated Garcinia kola seeds.*

| Treatment | CGP (%) | SD (±) |
|---|---|---|
| T1 (Control — no soaking) | 38 | 4.2 |
| T2 (24-hour soaking) | 56 | 5.1 |
| T3 (48-hour soaking) | 64 | 4.8 |
| T4 (72-hour soaking) | 80 | 3.9 |

CGP = Cumulative Germination Percentage.

### 3.3. Complete Dormancy Period

The CDP ranged from 35 days (T4) to 63 days (T1), exhibiting a systematic increase as soaking duration decreased (Figure 3). T4 had the shortest CDP, indicating the most rapid transition from dormancy to active germination, while T1 required the longest pre-germination period. This inverse relationship between soaking duration and CDP was consistent across all replicates.

Figure 3 showed that seeds in T4 had low dormancy period which made the seeds to germinate first. Seeds in T1 had the highest dormancy period which made the seeds to germinate last.

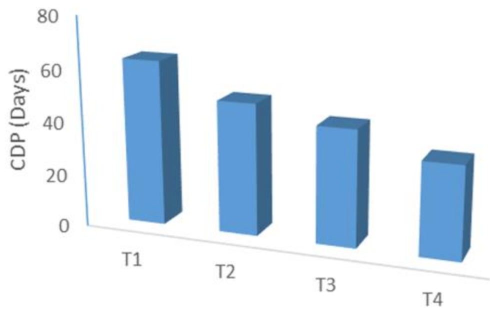


*Figure 3. Complete Dormancy Period (CDP) value for different treatments.*

## 4. Discussion

The results of this study demonstrate that water soaking duration significantly influences germination outcomes in decoated *G. kola* seeds, with 72-hour soaking (T4) consistently yielding superior performance across all measured parameters. These findings align with the established understanding that water is a critical factor enabling germination in tropical tree seeds, primarily through activation of enzymatic pathways essential for mobilization of stored embryo reserves [19].

The CDP values obtained in this study (35–63 days) were markedly shorter than those reported by [10] (70–109 days) and by [23] (95 days) for decoated *G. kola* seeds soaked for 24 hours in cold water, but somewhat longer than the 12–62 days reported by [26]. The lower CDP values in the latter study may partly reflect their use of transparent polythene bags, which facilitated earlier detection of radicle and plumule emergence.

The dual dormancy mechanism in *G. kola* seed coat dormancy and chemically-imposed physiological dormancy is consistent with prior reports [28, 33] Physical removal of the seed coat, combined with extended soaking, appears to facilitate the leaching of germination-inhibiting secondary metabolites from the embryo tissues, thereby enabling enzymatic activation and subsequent germination. The observation that T4 (72-hour soaking) produced the best results supports the view that prolonged imbibition is required to sufficiently hydrolyze stored seed reserves and stimulate embryo growth.

The relatively poor performance of T1 (unsoaked, decoated control) is instructive: although seed coat removal relieved physical dormancy, the chemically-imposed component remained intact, resulting in significantly delayed (Week 9) and low germination (38%). This parallels the findings of [3], who similarly observed that decoated unsoaked seeds first germinated at Week 9. These findings suggest that water soaking is an indispensable complement to decoating as a dormancy-breaking strategy.

The mechanism by which prolonged imbibition promotes germination in *G. kola* is likely consistent with the general model proposed by [32]: water absorbed through seed surface stomata enables enzymes to assume active conformational states, initiating the catalytic cascades necessary for germination. The enhancement of germination with increased soaking duration, up to 72 hours, is further consistent with [9], who demonstrated that extended soaking of *Cola lepidota* seeds improved germination uniformity relative to untreated controls.

Collectively, these findings suggest that both the physical barrier (seed coat) and chemical inhibitors within the seed contribute to dormancy, and that 72-hour soaking effectively addresses both components. Whether dormancy alleviation beyond 72 hours would yield further improvements remains to be investigated, as does the potential interaction between soaking temperature and duration.

*Limitations and future directions*

This study used seeds from a single mother tree and collection time, which limits generalizability. Additionally, seeds were not stored under varying farmer conditions. Future studies should include multiple seed sources, storage treatments, and longer soaking durations. No statistical significance testing (e.g., ANOVA) was performed; future work should include such analyses.

# 5. Conclusions

This study demonstrates that water soaking duration is a key determinant of germination success in decoated *Garcinia kola* seeds. Among the treatments tested, 72-hour soaking (T4) produced the most favorable outcomes, yielding the highest cumulative germination percentage (80%) and the shortest complete dormancy period (35 days). These results confirm that *G. kola* seeds exhibit a dual dormancy mechanism involving both seed coat resistance and chemically-imposed inhibition and that combining mechanical decoating with adequate water soaking effectively alleviates both components.

The proposed pre-germination protocol is simple, low-cost, and readily applicable by smallholder farmers and nursery practitioners without specialized equipment. Its adoption could substantially improve seedling availability for plantation establishment, thereby supporting conservation efforts and sustainable use of *G. kola*, a species under increasing pressure from overharvesting. Future investigations should explore the effect of soaking temperatures, soaking durations beyond 72 hours, and the use of alternative germination substrates on germination dynamics.

# Abbreviations

| | |
|---|---|
| CGP | Cumulative Germination Percentage |
| CDP | Complete Dormancy Period |
| MGT | Mean Germination Time |
| NTFP | Non-Timber Forest Product |
| SD | Standard Deviation |
| CRD | Completely Randomized Design |

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# Author Contributions

**Tchinmegni Felenou I:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing

**Djeukam Pougoum Stelle Vartant:** Formal Analysis, Investigation, Writing – original draft, Writing – review & editing

# Conflicts of Interest

The authors declare no conflict of interest.

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