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# Seed Dormancy Break and Initial Seedling Development of *Garcinia kola* (Heckel)

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***Authors' contributions***

*This work was carried out in collaboration between the two authors. Author AMO designed the study, performed the statistical analyses, wrote the protocol, wrote the first draft of the manuscript and managed the literature searches. Author EIM managed the analysis the study, read and approved the final manuscript.*

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## ABSTRACT

The aim of this study was to determine the best pre-treatment for the optimum germination of *Garcinia kola* Heckel and also to investigate its early growth characteristics. The study was conducted using 5 pre-treatments, these involved soaking 20 seeds of each treatment in cold water at room temperature for periods of 48, 72, 96 hours, 1 and 2 weeks respectively, before sowing, subjecting seeds to hot water treatment at 50°C, 70°C and 90°C for 30minutes respectively, treating seeds in concentrated sulphuric acid for 10, 30 and 60 minutes respectively; removal of the seed coat of seeds and the control seeds (no treatment). Top soil was used as germination medium. The results showed that removal of seed coat and also soaking of seeds in cold water for 96 hours respectively proved very effective for germinating the seeds of *G. kola* and were thus recommended for its propagation. Its growth rate (17cm in 20 weeks) was quite slow, by all standards, and this gives an indication of what it could be in nature, especially given the high population density in the tropical rain forest area of Nigeria where it naturally dominates. This possibly accounted for the species being almost extinct. Thus, this study has provided better understanding of its propagation which is needed by farmers, as this will help this all important threatened species from going into extinction.

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## 1. INTRODUCTION

*Garcinia kola* Heckel, often called bitter kola is an indigenous medicinal tree belonging to the family Clusiaceae, formerly Guttiferae.

It is highly branched, evergreen and grows as a medium- sized tree, reaching 12m high in 12 years, and found in moist forests throughout west and central Africa [1].

*Garcinia kola* has been proved as one of the many non-timber forest products that are of high socio-economic importance [2].

The many uses of the plant have resulted in its over exploitation which now threatens it with extinction in several west and central African countries such as Coted'Ivoire, Togo [3,4,5].

In Nigeria, low populations of the plant are found in home gardens and few stands are found in the wild due to rapid deforestation and heavy exploitation in the natural forests [6].

The major difficulty in propagating *G. kola* and other Garcinia genus is related to seed germination [7].

Due to dormancy, *Garcinia kola* seeds can take 18 months to germinate [8].

Researchers have studied the germination problems of *Garcinia kola* seeds and suggested various means of breaking its dormancy [9,10,11].

*Garcinia kola* seeds have both seeds coat dormancy and physiological dormancy probably imposed by the chemicals in the seed [10].

Nzegbule and Mbakwu, [12] had reported the presents of a substance associated with germination inhibition, phenol, in the seed of *G. kola*.

However, there is still a need to investigate simple and practicable methods that farmers could easily adopt with low technological input, to improve the germination of *Garcinia kola* which is not available now in the South Eastern Nigeria.

The main objective of the study therefore was to investigate the best methods to break dormancy and improve germination of *Garcinia kola* seeds within a short time using pre-treatments and to investigate its early growth characteristics.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study was conducted around Agu-Awka, near Esther Obiakor estate, behind government house, Awka, Anambra state Nigeria, Awka is a town that lies between latitude (7°00' and 7°10')N and longitudes (6° 05' and 6° 15')E in the rain forest of Nigeria [13] Representative seed samples were collected from the market at Awka in November. The bulked seed lot was thoroughly mixed and transported to the study area. The containers used for collecting the seeds gave an open packing arrangement that ensured good flow of air around the seeds and thereby facilitated drying and also reduced the hazards of mould attack and decay.

Simple float test and a cut test were used to determine the internal state of the seeds (generally full. shriveled or empty). Shriveled seeds were removed before the dormancy-breaking treatments.

**Seed pre-treatment-** five treatments were used.

**Treatment one-** 20 seeds of each treatment were soaked in clean cold water at room temperature for periods of 48, 72 and 96 hours respectively and also for 1 and 2 weeks.

**Treatment two-** this involved subjecting 20 seeds in each to hot water treatment ranging from 50°c, 70°c and 90°c for 30 minutes in each case.

**Treatment three-** this involved treating 20 seeds with concentrated tetraoxosulphate IV acid for varying periods of time ranging from 10 minutes, 30 and 60 minutes. The seeds were properly rinsed with distilled water before sowing in poly bags.

**Treatment four-** this involved removal of the seed coats before sowing.

**Treatment five-** was the control where 20 untreated seeds were sown into the poly bags.

Manually, water was applied daily so that the medium was kept moist at all times without getting water-logged.

$$\% \text{ germination} = \frac{\text{No. of seeds that germinated} \times 100}{\text{Total no. of seeds sown} \quad 1}$$

The choice of the different treatment levels for temperature, cold water and concentrated acid were randomly taken.

Simple viability tests were conducted on the seeds before the dormancy breaking treatments.

## 2.2 DATA Collection and Analysis

In the nursery, the criterion for germination was a visible protrusion of the shoot apex or epicotyls on the surface of the soil.

Germination was recorded daily until no further germination occurred.

Data on percentage germination, cumulative germination, complete dormancy period, total dormancy period, differential dormancy period, germination rate [14] and germination speed were collected.

Also weekly measurements of the height of the seedlings, leaf area and number of branches were recorded to determine the early growth characteristics.

Photographs of the seedlings were taken at different developmental stages.

**Complete dormancy period-** The duration (days) from the date of sowing to the date of first germination was recorded, for each treatment.

**Total dormancy period-** The duration (days) from the date of sowing to completion of germination for each treatment was recorded.

**Differential dormancy period-** The difference between the total dormancy period and the complete dormancy period (days) was recorded for each treatment.

**Germination speed-** The number of days it took for 50% of the sown seeds to germinate was recorded for each treatment.

**Cumulative germination-** The total number of seeds that germinated throughout the period of experiment was recorded for each treatment.

**Percentage germination-** The total number of seeds that germinated divided by the number of seeds sown multiplied by 100 recorded for each treatment.

**Germination rate**- A record of the total number of seeds that germinated per number of days in the germinator was taken for each treatment.

The height of the seedlings was measured using metre rule; also length and width of the leaf were measured.

The leaf area was calculated by leaf length a leaf width.

The mean seedling height and leaf area were calculated. The number of leaves was counted and recorded.

The experiment lasted for seven months. (212 days).

## 3. RESULTS

The seeds of *Garcinia kola* showed hypogeal germination (Plate 1).

Treatments studied had profound effects on the germination periods of *Garcinia kola*. Germination commenced after 62 days of sowing with seeds whose seed coat was removed.

For the intact seeds soaked in cold water for durations of 48 hours, 72 hours, 96 hours, 1 week and 2 weeks, germination commenced at 85, 84, 110, 88 and 97 days respectively (Table 1).

Germination was faster and more abundant when the seed coat was removed than soaking of intact seeds for various time durations.

(Table 1). Seeds whose seed coats were removed equally recorded the highest germination percentage of 95% while the control seeds (no treatment) and seeds soaked in hot water ($50^{o}$c) had the lowest germination percentage of 55% (Table 1).

It is equally worth pointing out that seeds soaked in cold water for 96 hours recorded a germination percentage of 85%.

**Table 1. Summary of results of complete dormancy period, total dormancy period, differencial dormancy period, germination speed, cumulative germination, percentage germination and germination rate across the treatments**

| Treatments | Complete dormancy period 1st germination (days) | Total dormancy period (TDP) (days) | Differential dormancy period(DDP) (days) | Germination speed (GS) days | Cummulative germination (CG) (days) | Percentage (%) germination (GP) (days) | Germination rate(GR) (No. per day) |
|---|---|---|---|---|---|---|---|
| Seeds soaked in cold water (48hrs) | 85 | 212 | 127 | 85 | 15 | 75 | 0.07 |
| Seeds soaked in cold water (72hrs) | 84 | 164 | 80 | 42 | 15 | 75 | 0.07 |
| Seeds soaked in cold water (96hrs) | 110 | 183 | 73 | 24 | 17 | 85 | 0.08 |
| Seeds soaked in cold water (1 week) | 88 | 212 | 124 | 74 | 12 | 60 | 0.05 |
| Seeds soaked in cold water (2 week) | 97 | 212 | 115 | 71 | 15 | 75 | 0.07 |
| Hot water treatment for 30 mins ( 50$^{o}$c) | 105 | 212 | 117 | 82 | 11 | 55 | 0.05 |
| Hot water treatment for 30 mins (70$^{o}$c) | - | - | - | - | - | - | - |
| Hot water treatment for 30 mins (90$^{o}$c | - | - | - | - | - | - | - |
| Conc. Sulphuric acid treatment for 10 mins | - | - | - | - | - | - | - |
| Conc. Sulphuric acid treatment for 60 mins | - | - | - | - | - | - | - |
| Removal of seed coat | 62 | 131 | 69 | 9 | 19 | 95 | 0.09 |
| Control seeds (No treatment) | 114 | 212 | 98 | 70 | 11 | 55 | 0.05 |

All the seeds treated in hot water at 70°C and 90°C and all seeds treated with concentrated sulphuric acid at various time durations failed to germinate (Table 1).

Table 1 also shows that seeds whose seed coats were removed had low total dormancy period, hence germinated first, intact seeds soaked in cold water between 72-96 hours had comparatively moderated complete dormancy period, hence were the next to germinate while seeds soaked in water for 48 hours, 1 week, 2 weeks and seeds soaked in hot water (50°c) and the control seeds (no treatment) had maximum total dormancy period in this study, hence delayed germination.

Complete dormancy period ranged from 62-114 days in this investigation.

### 3.1 Mean Height of the Seedlings, Leaf Area and Number of Leaves and Branches

There was a steady increase in seedling height with time (Table 2).

The leaf area also increased with time, then stopped at 14 weeks (Table 2). The number of the bifoliate leaves equally increased with time (Table 2, Plates 1 and 2). There was no development of branches observed within the period of twenty weeks of study (Table 2).

**Plate 1. Hypogeal germination in *G. kola***

**Plate 2. Early developmental stages in *G. kola***

**Table 2. Mean height of seedlings, leaf area and number of leaves and branches**

| Week | Seedling height (cm) | Leaf area $(cm)^2$ | No. of leaves | No. of branches |
|---|---|---|---|---|
| 1 | | | | |
| 2. | 9.0 | 4.50 | 2 | - |
| 3. | 9.5 | 11.25 | 4 | |
| 4. | 10.0 | 21.44 | 4 | - |
| 5. | 10.05 | 34.03 | 6 | - |
| 6. | 12.0 | 37.84 | 6 | - |
| 7. | 13.0 | 40.50 | 6 | - |
| 8. | 13.2 | 40.50 | 6 | - |
| 9. | 13.5 | 54.00 | 6 | - |
| 10. | 15.0 | 54.90 | 6 | - |
| 11. | 15.5 | 56.25 | 8 | - |
| 12. | 16.0 | 56.25 | 8 | - |
| 13. | 16.0 | 56.25 | 8 | - |
| 14. | 16.0 | 58.50 | 10 | - |
| 15. | 16.2 | 58.50 | 10 | - |
| 16. | 16.5 | 58.50 | 10 | - |
| 17. | 16.5 | 58.50 | 10 | - |
| 18. | 16.7 | 58.50 | 10 | - |
| 19. | 16.7 | 58.50 | 10 | - |
| 20. | 17.0 | 58.50 | 10 | - |

*Mean(x) = 14.147; mean(x) = 46.22; mean(x) = 7.368; S.E = 0.629; S.E = 3.97; S.E = 0.573; Con. Limit = 14.147 con. Limit = con limit = + 0.629 46.22+3.97 7.368+0.573 at 95%*

## 4. DISCUSSION

The complete dormancy period obtained in this investigation ranged from 62- 114 days. These values were lower than 70-109 days obtained by Oboho and Ogana [11] in the germination of *Garcinia kola* seeds and also lower than 95 days for 1st germination obtained by Eyog-Matig [15], for decoated *Garcinia kola* seeds soaked in cold water (30°C) for 24 hours but higher than 12-62 days obtained by Yakubu et al. [7] in the germination of decoated *Garcinia kola* seeds and also higher than 35-63 days obtained by Bolanle-Ojo et al. [16] in the germination of decoated and soaked *Garcinia kola* seeds.

Seed coat removal yielded the best result in this investigation suggesting that part of the dormancy in *G. kola* is seed coat induced. This agrees with the report of Thomlinson et al. [17] that seed cot may be overcome by peeling off the coat.

Soaking of coated seeds in cold water for 96hours proved effective in his investigation also. This could be due to the water dissolving the impermeable seed coat, hence allow water and oxygen into the embryo of the seed and enhance germination. Soaking of seeds one and two weeks yielded poor germination in this investigation. This could be due to microbial attack and subsequent destruction of the embryo.

When the coated seeds were soaked in hot water for 30 minutes at various temperatures, germination occurred at 50°C, and not above it since seeds treated at 70°C and 90°C failed to germinate. Germination failure was previously reported when soaking *Garcinia kola* seeds in warm water (60°C) for 8 hours [12] and this confirms that warm water treatment affected negatively the germinations of *Garcinia kola* seeds.

Coated seeds in hot water (50°C) germinated showing that seed coat may protect, to a certain extent, the embryo from destruction by warm water.

When the seeds were treated with concentrated tetraoxosulphate VI acid ($H_2SO_4$), at various time durations, they all failed to germinate.

It appeared the concentrated acid charred the thin seed coat and destroyed the embryo.

Similarly, Aliero [18], reported that prolonged emersion of seeds in $H_2SO_4$ injured the seeds since the acid could destroy vital parts of the embryo.

The untreated seeds (the control) recorded the longest complete dormancy period of 114 days and also the least percentage germination of 55%. This reflects the dormancy in *Garcinia kola* seeds.

It appeared that seed coats of *Garcinia kola* restricted water supply and gaseous exchange into the embryos and inhibited germination in the control treatment.

## 5. CONCLUSION

This work has revealed certain important aspects of the ecology and biology of *Garcinia kola*.

- Its seeds showed seed coat dormancy problems which can be broken by removing the seed coat and also soaking intact seeds in cold water at room temperature for 96 hours or there about.
- Soaking treated seeds in hot water and concentrated sulphuric acid for different periods negatively affected the germination of the seeds.
- The high percentage germination recorded in this research work can be attributed to regular supply of water to the seeds in the nursery from sowing to germination.
- It shows hypogeal germination
- The cotyledons are not separated (eudicot)
- The bifoliate leaves show alternate leaf arrangement
- Water in the soaked seeds were changed every 24 hours hence no problem of microbial infection.
- The seedlings exhibit a very slow growth rate (17cm in 20 weeks).

Because of these attributes of the seed, it is difficult to germinate and grow profusely in the wild. A better understanding of its propagation is needed by farmers through good nursery and agro-forestry practices.

This will help this all- important, threatened species from going into extinction.

## DISCLAIMER

This paper is based on preliminary dataset. Readers are requested to consider this paper as preliminary research article, as authors wanted to publish the initial data as early as possible. Authors are aware that detailed statistical analysis is required to get a scientifically established conclusion. Readers are requested to use the conclusion of this paper judiciously as statistical analysis is absent. Authors also recommend detailed statistical analysis for similar future studies.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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