Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019http://www.ajol.info/index.php/jrfwe
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E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Omokhua et al., 2019

INFLUENCE OF PRE-GERMINATION TREATMENTS ON GERMINATION AND EARLY SEEDLINGS GROWTH OF *Carapa procera*

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ABSTRACT

This study was carried out at the Forest Nursery of the Department of Forest and Wildlife Management, Faculty of Agriculture, University of Port Harcourt Nigeria. It assessed the effect of pre-germination treatments on seed germination and early seedling growth performance of Carapa procera. The experiment was laid out in a completely randomized design involving analysis of variance. Duncan multiple range test (DMRT) at (P<0.05) was used for mean separation. The treatments used were: hot water soaking (5 minutes), mechanical scarification, cold water soaking (24 hours) and the control. A total of 600 seeds were used for germination (i.e. 150 seeds per treatment). Observations on germination were recorded daily for six weeks on germination emergence, duration and percentage. A total of 80 seedlings were used i.e. 20 seedlings of uniform height at two (2) leaves stage for each treatment were transplanted into polypots, Evaluation of early seedling growth was done for four months based on height, collar diameter and leaf number. Highest Germination percentage was observed in mechanically scarified seeds (94%) and lowest in control seeds (56%). Earliest emergence and duration was observed in mechanically scarified seeds (5 and 4 days respectively) and latest in control (21.67 and 29.33 days respectively). A significant effect (p ≤ 0.05) was observed in all growth parameters at all stages of growth. Mechanically scarified seeds produced the highest performance for all growth parameters studied followed by control when compared to the other pre-treatment methods. It is recommended that seeds of Carapa procera be mechanically scarified before sowing. Although other treatments can be used to enhance germination, they may not be required for seedling growth since seedlings from untreated seeds produced higher growth parameters after scarification treatment.

Keywords: *Carapa procera*, pre-treatments, germination, early seedling growth

INTRODUCTION

Carapa procera DC is a genus of flowering plants in the Mahogany family Meliaceae (Orwa *et al.*, 2009). It is commonly known in Nigeria as Agogo (Yoruba), Irere (Benin), Nkwo (Igbo), crabwood and bastard mahogany (English). (Orwa *et al.*, 2009). It is a deciduous or semi-evergreen tree that grows up to 35m tall. The bole is straight and cylindrical, branchless up to 20m and 100cm in diameter, bark is light grey to greyish brown or dark brown. Young plants produce taproots, but the tree tends to become surface rooted. Leaves are alternate, with dormant glandular leaflet at the apex, pinnate leaves are usually 6-9 pairs on a stalk. Flowers are small, whitish in colour. According to an article from Agroforestry.org entitled *Carapa procera* (*C. grandiflora*) *Meliaceae* (n.d), the fruits cracks open into 5 pairs when it falls to the ground releasing 12-20 smooth seeds each 3cm, shiny dark brown in colour and angular in shape.

Carapa procera oil is one of the most sold medicinal oils; it is used to repel mosquitoes, can be formed into paste and applied topically to protect the body from mosquito bites (Miot *et al.*, 2004). The wood is mainly used for high quality furniture and cabinet work, stairs and flooring and as veneer for furniture, interior work and plywood. It is also used as building materials. In Columbia, shoemakers prefer it for making shoe pieces (Kenfack and Peréz 2011).

Experiences have shown that lack of technical knowledge on how to improve propagation or germination for this species with hard seed coat, presents a major hindrance to nursery operators and farmers wishing to grow these species. Dormancy is an obstacle to the germination of sown seeds and may be caused by physical or physiological factors. According to Finch-Savage and Leubner-Metzger, 2006) "Seed dormancy could be considered simply as a block to the completion of germination of an intact viable seed under favourable conditions". This phenomenon has necessitated the need to device a means of breaking it through pre-treatment. To ensure uniform and rapid germination of any seed, the cause of the dormancy must be identified and removed before the seed is sown (Adedire *et al.,* 2008). Pre-germination treatment has helped farmers as well as silviculturists to hasten germination of their seeds and obtain a more increased productivity.

The world's forests play an important role in maintaining fundamental ecological processes as well as providing livelihood and supporting economic growth (FAO, 2014). However, the over-exploitation of forest resources has endangered tree species including *Carapa procera*. Secondly, there is inadequate knowledge of silvicultural techniques for *Carapa procera,* because the seeds are recalcitrant. The slow process of natural regeneration of many tropical species and the threat of extinction makes it necessary to develop the silvicultural technique for the species. This study has provided information on silvicultural techniques for regeneration of the species. The objective of this study was to determine the effect of four (4) pre-treatment methods which included: hot water (5 minutes), mechanical scarification, cold water (24 hours) and a control (no treatment) on germination and early seedlings growth of *Carapa procera.*

MATERIALS AND METHODS

Study site

The study was carried out at the nursery site of the Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Port Harcourt on Latitudes 4.90794 and 4.90809 N and Longitudes 6.92413 and 6.92432 E in Obio/Akpor Local Government Area of Rivers State (Chima *et al.,* 2017).

Fruit Collection and Seed Processing

The fruits of *Carapa procera* were harvested from 'plus' trees in an arboretum in a natural lowland rainforest in Benin City, Edo State, Nigeria. The seeds were extracted manually. The processed seeds were subjected to viability test through floatation method, the seeds that floated after minutes of soaking were considered unviable and discarded while those that sank were used for the study.

Experimental Design and Treatment Procedure

Seed Germination

The completely randomized design (CRD), involving 4 treatment with 3 replicates was used ~~in~~ for the study. The pre-germination treatments involved soaking seeds of *Carapa procera* in hot water (5 minutes), mechanical scarification, (using nail cutter) cold water (24 hours) and a control. A total of six hundred (600) seeds *were* used for the experiment at 150 seeds per treatment and 50 per replicate. Pre-treated seed were sown in germination trays, filled with washed and sterilized river sand to prevent damping off and the germination trays were placed inside a propagator to conserve moisture. The trays were monitored and watered daily in the morning to maintain adequate moisture content. Germination was assessed to have occurred at the point of radicle emergence on the soil medium. Germination of seeds lasted for six (6) weeks.

Data collected on germination was used to calculate germination percentage (GP), germination emergence (GE) and germination duration (GD) for each treatment using the formulae below.

$$GP = \frac{Number\ of\ germinated\ seeds}{Number\ seeds\ sown} * \frac{100}{1}$$

GE = Seeds germination time after sowing.

GD = period of germination emergence to the end of germination.

Where:

GP = Germination Percentage

GE = Germination emergence

GD = Germination duration

Seedlings Growth Performance

For each treatment, 20 seedlings of uniform height at two (2) leaves stage were transplanted into polypots filled with topsoil from forest floor. Each of the polypots was taken as a replicate of its own. A total of 80 seedlings were used. Seedlings were watered daily and measured immediately after transplanting and monthly thereafter for five (5) months. Seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a digital calliper while leaf production were determined by directly counting the number of leaves.

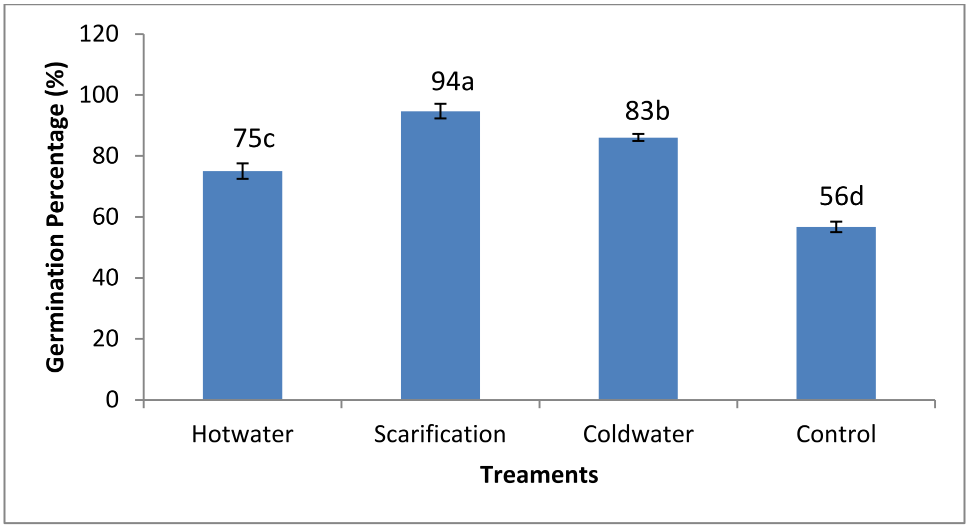
Data Analysis

Data collected on germination and early seedling growths were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). Analysis of variance was carried out to test the effect of treatments on seeds and seedlings of *Carapa procera*. .Duncan Multiple Range Test (DMRT) (at $p \leq 0.05$ level of significance) was used for means separation.

RESULTS

Effect of pre-treatments on germination percentage of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed germination percentage. The mean germination percentage varied from 56 to 94% (Figure 1). Mechanically scarified seeds exhibited highest germination percentage (94%), followed by seeds immersed in cold water (83%), seeds immersed in hot water (75%) while control exhibited lowest germination percentage (56%).

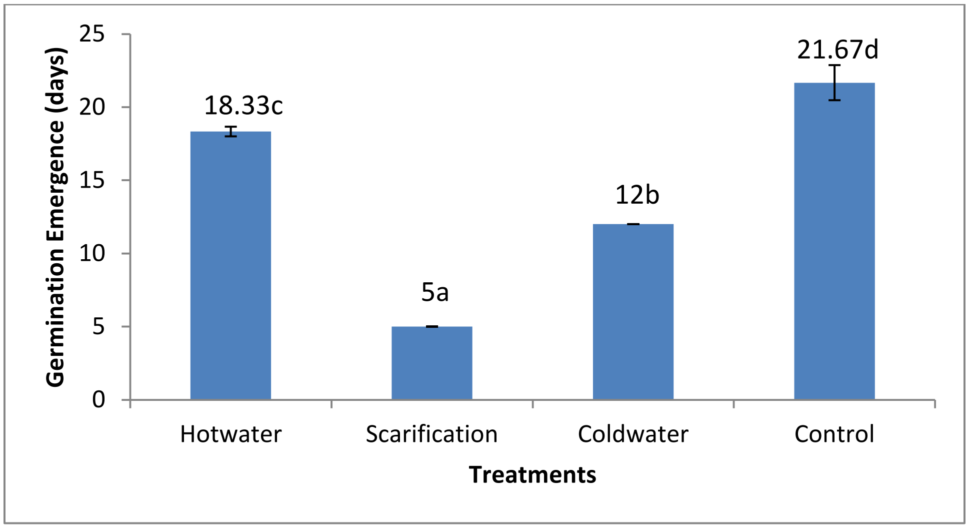


Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 1. Effects of seed pretreatment on germination percentage of *Carapa procera.*

Effect of pre-treatments on germination emergence of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed emergence. The number of days which pre-treated seeds of *Carapa procera* took to emerge after sowing was earliest in mechanically scarified seeds (5 days) when compared to seeds immersed in cold water (12 days), seeds immersed in hot water (18.33 days) and control (21.67 days) as presented in Figure 2.

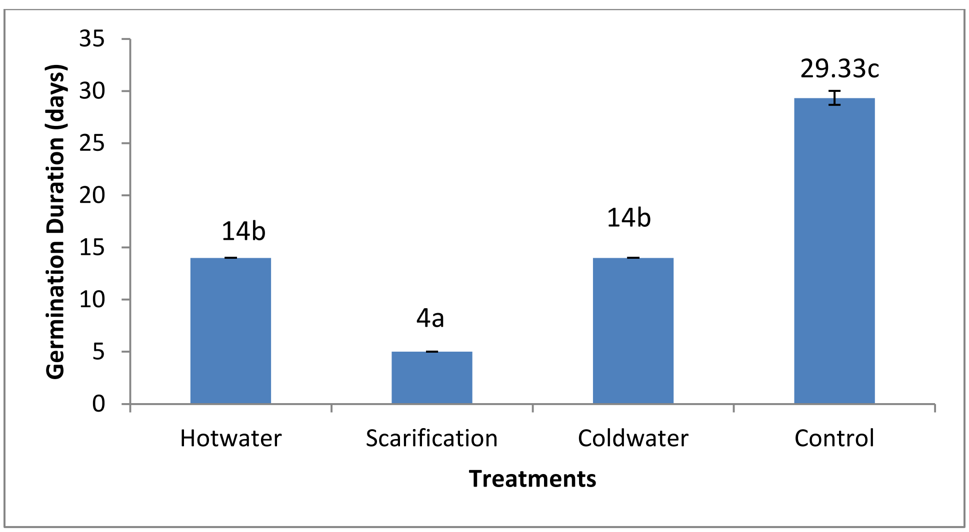


Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 2. Effects of seed pre-treatment on germination emergence of *Carapa procera.*

Effect of pre-treatments on germination duration of *Carapa procera*

There was significant variation ($p \leq 0.05$) among treatments in seed germination duration. Mechanically scarified seeds exhibited lowest germination duration (4 days) followed by seeds immersed in cold water and hot water (14 days) while control had highest germination duration(29.33 days). Summary of this result is presented in Figure 3.



Bars with the same letter (s) are not significantly different at the 0.05 level.

Figure 3. Effects of seed pre-treatment on germination Duration of *Carapa procera.*

Effect of pre-treatments on seedling height (cm) of *Carapa procera*

Seedlings of *Carapa procera* displayed significant differences ($p \leq 0.05$) in height from 1 to 6 months of growth in the nursery. Overall mean seedling height after 1 to 6 months varied from 9.89 cm at month 1 to 25.56 cm at month 6 (Table 1). Mechanically scarified seedlings exhibited highest height at 1 to 6 months (15.83, 16.56, 19.72, 21.61, 23.61 and 25.56cm respectively) while control and cold water treated seedlings had lowest height at month 1 and 2 (9.89 and 11.92 cm respectively) and hot water treated seedlings at month 3 to 6 (12.87, 15.24, 16.92, 18.93cm respectively) (Table 1).

Table 1. Effect of seed pre-treatment on mean seedling height (cm) of *Carapa procera*

	Seedling height (cm)					
Treatments	**HT1**	**HT2**	**HT3**	**HT4**	**HT5**	**HT6**
Hot water	10.98a	12.13a	12.87a	15.24a	16.92a	18.93a
Scarification	15.83b	16.56b	19.72b	21.61b	23.61b	25.56b
Cold water	9.91a	11.92a	13.92a	15.93a	17.93a	19.94a
Control	9.89a	11.97a	13.87a	15.88a	17.87a	19.82a
Mean	11.65	12.89	15.09	17.17	19.08	21.06
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
HT1-6 = height of seedlings at month 1 to 6.

Effect of pre-treatments on seedling collar diameter of *Carapa procera*

Seedlings of *Carapa procera* subjected to different pre-treatments displayed significant differences ($p \leq 0.05$) in seedling collar diameter from the first to the sixth month. Overall mean collar diameter after month 1 to 6 months varied from 0.59mm at month 1 to 1.05mm at month 6 (Table 2). Mean Seedling collar diameter was considerable highest in mechanically scarified seedlings at 1 to 6 months (0.82, 0.89, 0.94, 0.95, 0.99 and 1.05 cm respectively) followed by control (0.72, 0.73, 0.78, 0.80, 0.81 and 0.90 cm respectively) and lowest in hot water-treated seedlings (0.59, 0.61, 0.63 0.70, 0.74 and 0.86 cm respectively) (Table 2).

Table 2. Effect of seed pre-treatment on mean seedling collar diameter (cm) of *Carapa procera*

	Seedling collar diameter (cm)					
Treatments	**CD1**	**CD2**	**CD3**	**CD4**	**CD5**	**CD6**
Hot water	0.59a	0.61a	0.63a	0.70a	0.74a	0.86a
Scarification	0.82c	0.89c	0.94c	0.95b	0.99b	1.05b
Cold water	0.66ab	0.68ab	0.77b	0.77a	0.80a	0.87a
Control	0.72b	0.73b	0.78b	0.80a	0.81a	0.90a
Mean	0.70	0.73	0.78	0.80	0.84	092
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.012

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
CD1-6 = Collar Diameter at I month to 6 months

Effect of pre-treatments on seedling leaf number of *Carapa procera*

Significant variations ($p \leq 0.05$) were also observed for number of leaves among pre-treatments throughout the stages of growth. Overall mean leaf number after 1 to 6 months ranged from 2.78 at month 1 to 7.22 at month 6 (Table 3). Highest leaf number after 1 to 6 months was observed in mechanically scarified seedlings (3.22, 4.22, 4.72, 6.00, 6.78 and 7.22 respectively) while lowest leaf number at month 1 to 3 was observed in cold water-treated seedlings (2.78, 3.44 and 3.78 respectively) and month 4 to 6 in hot water treated seedlings (4.00, 4.81 and 5.00 respectively) (Table 3).

Table 3. Effect of seed pre-treatment on mean seedling leaf number of *Carapa procera*

	Seedling leaf number (cm)					
Treatments	**LN1**	**LN2**	**LN3**	**LN4**	**LN5**	**LN6**
Hot water	3.00a	3.72ab	3.83a	4.00a	4.81a	5.00a
Scarification	3.22b	4.22b	4.72b	6.00b	6.78a	7.22bc
Cold water	2.78a	3.44a	3.78a	4.72ab	4.83a	5.33ab
Control	2.94a	4.00ab	4.28ab	5.22c	6.58b	7.00c
Mean	2.99	3.85	4.15	4.99	5.36	5.89
P value	0.001	0.051	0.004	<0.001	<0.001	<0.001

Values in the same column with the same subscript letter do not differ significantly ($p \leq 0.05$).
LN1-6 = number of leaves at month 1 to 6.

DISCUSSION

Several studies have shown that different methods of pre- treatments can enhance germination rate and speed up germination process (Hossain *et al.*, 2005). The result of this study shows that there were significant variation ($p \geq 0.05$) among pre-treatments in seed germination percentage, germination emergence and germination duration. Germination started on the fifth day after sowing in scarified seeds and lasted for four weeks in control seeds. Mechanical scarification also exhibited lowest germination durations and highest germination percentage when compared to other treatments used. According to Azad *et al.*, (2010), nicking is known to break physical dormancy of seeds with hard coats which inhibits water uptake and gases. Missanjo *et al.*, (2014) also noted that earlier germination of nicked seeds is a result of cracks or cuts made on the seed which makes it easier for entry of water and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into seedlings. The highest germination percentage observed in scarified seeds is in agreement with the study carried out by Asinwa *et al.* (2012) who observed increased germination percentage of *Calophylum inophylum* seeds treated with scarification and the findings of Fredrick *et al.* (2016) who noted that mechanically scarified seeds had highest germination percentage in *Faidherbia albida* seeds when compared to other treatments used in the study. Aref *et al.* (2011) and Boltsheleng *et al.* (2014) also observed highest germination percentage in five *Acacia spp* and *Afzelia quanzensis* and *Baikiaea plurijuga* seeds treated with scarification. Higher germination parameters observed in cold water could be attributed to the fact that soaking seeds in cold water before planting helps to break down the seed's natural defence against what it expects from nature which then allows it to germinate faster, boost the moisture content around the seeds, which signals to the seeds that it is now safe to grow. This agrees with the findings of Fredrick *et al.*, (2016) who reported that cold water treatment of *F. albida* gave a fair germination percentage and a reduced mean germination time when compared to hot water treatment and the control.

Hot water treatment also enhanced germination of *Carapa procera* seeds. According to Tadros *et al.* (2011) hot water was the most effective presowing treatment in both *Leucaena leucocephala* and *Acacia farnesiana* species compared to sandpaper scarification and the control. Botsheleng *et al.* (2014) reported that hot water treatment was the best treatment for *B. plurijuga* seeds as it attained the maximum germination percentage (100%) and noted that this could be attributed to the weak seed coat of the species. According to Mwase and Mvula (2011), hot water treatment of seeds makes the seed coats permeable to water and the seeds imbibe and swell as the water cools. Poor germination parameters observed in the control treatment is an indication that seeds of this species need to be pre-treated to enhance its germination. Amusa, (2011) and Falemara *et al.*, (2013) noted that the control exhibited longer germination commencement period in *Afzelia africana* and *Adansonia digitata* respectively when compared with other treatments used in their studies. This also conforms to the report by Iroko *et al.* (2013) on the germination of *Vitellaria paradoxa* which showed that the seeds of the species needed to be pre-treated to enhance germination. The result of this study is in conformity with the statement by Luna *et al.*, 2009 that 'the conditions necessary to allow seeds to break dormancy and germinate can be highly variable among species, within species or among seed sources of the same species' with respect to the parameters measured

Pre-treatments significantly affected all growth parameters (seedling height, collar diameter and leaf number) at all stages of growth. Mechanically scarified seeds produced the highest performance for all growth parameters studied (seedling height, collar diameter and number of leaves growths) followed by the control when compared to the other pre-treatment methods. This is the best method that could be used to enhance growth of *Carapa procera* seeds. According to Missanjo *et al.*, 2014, fast growth of *Acacia polyacantha* seedlings from nicked seeds occurred because seedlings from nicked seeds had an advantage of absorbing much water and started the photosynthetic process much faster than others. Seed germination is the most important stage that affects earlier seedling growth and establishment (Tian *et al.* (2014).This result agrees with that of Karaguzel *et al.* (2004) and Missanjo *et al.* (2014) who observed that nicking produced the highest performance for all growth parameters studied in seeds of *Lupinus varius and Acacia polyacantha* respectively.

Higher collar diameter and leaf number produced by the control implies that although *Carapa procera* seeds may require pre-treatment to enhance germination, it does not need to be pre-treated to enhance early growth characteristics. Lowest seedling growth parameters observed in hot water is an indication that hot water treatment is detrimental to the growth of *Carapa procera* seedlings. This finding is contrary to that of Omokhua *et al.*, 2015 who reported that hot water treatment exhibited higher growth parameters when compared to the control in *Maesobotrya barteri* seedlings.

CONCLUSION

The result obtained in this study revealed that pre-germination treatments significantly enhanced the germination process of *Carapa procera* seeds. As the seed coat of *Carapa procera* is hard, it takes more time to germinate with lower germination percentage. However, effective pre-sowing treatments can ensure successful germination. The pre-treatment of *Carapa procera* seeds using scarification was the best treatment that enhanced germination of the seeds and growth of seedlings. Although other treatments can be used to enhance germination, they may not be required for seedling growth since seedlings from untreated seed produced higher growth parameters after scarification treatment.

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