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Research Article

Influence of Pre-Sowing Treatments on Seed Germination of Bush Candle Tree (*Canarium schweinfurthii* Engl.)

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Abstract

Canarium schweinfurthii (Burseraceae) is an important source of energy, medicine, food, and income to the people of the Western Highlands of Cameroon. The population of the tree has declined tremendously in recent years as regeneration from seed is hampered by a hard seed coat that makes germination difficult. The aim of this study was to test the effect of pre-sowing treatments on germination of *C. schweinfurtheii* seeds. Seeds were subjected to the following treatments before planting in a non-mist propagator: untreated control, immersing in water warm at 60° C for 2 hours, soaking in dilute HCl for 2 hours, dry heating at 100 °C for 2 hours, and dry heating at 60 °C for 24 hours. Germination indices were computed from a daily recording of germination. Data were analyzed in one-way ANOVA and means separation were conducted with Tukey LSD. The dry heat at 100 °C and 60 °C pre-treatments were lowest in Final Germination Percentage (FGP), Mean Germination Time (MGT), and Germination Rate Index (GRI). The ranking of the other pre-treatments was dependent on the parameter. The immersion in warm water significantly augmented FGP. The HCl treatment increased FGP to an extent comparable to warm water but it also increased GRI. Furthermore, MGT was lowest in HCl treatment relative to warm water and the control. In conclusion, the warm water and HCl treatments are useful alternatives for enhancing seed germination of *C. schweinfurtheii*. To speed up and complete germination in a shorter period of time, however, HCl is preferred.

Keywords: ***Canariumschweinfurtheii, Germination traits, Pre-sowing treatments, Wetland tree*.**

Introduction

Canarium schweinfurthii Engl, commonly known as bush candle tree, is a member of Burseraceae family. The tree is found throughout tropical Africa (Anozie and Oboho, 2019; Tchouamo, *et al.*, 2000), ranging from Senegal to Cameroon and extending to Ethiopia, Tanzania and Angola (Kuete, 2017). *Canarium schweinfurthii* is an evergreen, large tree with a fluted, buttressed trunk, heavy lateral branches and a dense canopy *with its crown reaching to the upper canopy of the forest, with a long clean, straight and cylindrical hole exceeding 50 m* and a trunk diameter of more than 150 cm in dense evergreen humid forests, semi-deciduous forests, secondary forests, gallery forests and dry forests (Orwa, 2009). The fruit has an appearance similar that of olive tree and has a light green color that becomes dark purple or black as it ripens. The flowers grow in clusters

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at the end of the twigs and are small and dark green in color. Fruits which are of two varieties (long spiral and short round in shape) develop from the flowers. The fruits contain single triangular shaped seed with small projections at the three faces. The seeds are embedded in a purplish green pulp which is oily and edible, with a desirable sweet but not too sugary taste similar to that of avocado pear. The fruit can be eaten raw or after softening in warm water (Dawang, *et al.*, 2016).

Canarium schweinfurthii is a multipurpose tree. It is a source of energy, medicine, food and has significant socio-cultural value (Tchiegang, *et al.*, 2002). Ranging from the roots to the leaves, the tree is desired for all its parts. It tree makes a good fuelwood that ignites with relative ease and releases a lot of heat on burning. The fruit that is produced in the rainy season (usually April to September) and available or eaten from October to December is a good source of oil. *Canarium schweinfurthii* is among the trees whose fruit is commonly found in the natural diet of peoples in the Western Highlands of Cameroon. In addition to direct consumption by rural producers, its sale constitutes an important source of income (Tsewoue, *et al*., 2019; Traoré, *et al.*, 2021). Leaves are used alone or combined with other herbs for treatment of cough, cold, malaria, constipation, diarrhea, post-partum pain, rheumatism and sexually transmitted diseases (Tcheghebe, *et al.*, 2016). The pounded bark is used for treating leprosy and ulcers and a bark decoction is effective against dysentery, gonorrhea, coughs, chest pains, pulmonary affections, stomach complaints, and food poisoning. The resin is used against roundworm and other intestinal parasite infection while the root is used against adenitis. The wood is used for constructing canoes, mortars, flooring, furniture, and general utility purposes (Orwa, *et al*., 2009). In the Western Cameroon Highlands, interest in the tree lies for the most part on its fruits and wood.

In spite of the positive impact of *C. schweinfurthii* on the daily life of the peoples of the Western Highlands of Cameroon, the population has declined to a very low level because of the lack of inadequate knowledge on its silviculture. *Canarium schweinfurthii* can be propagated by sexual or vegetative methods. However, vegetative propagation of the species is usually very slow and success rate is quite low. According to Hartmann, *et al.*, (2011), sexual propagation by seeds is very important means of plant propagation as it ensures genetic diversity and is cheaper than asexual propagation. Thus, growing *C. schweinfurtii* from seed is a useful alternative to overcoming the difficulties associated with vegetative propagation. The problem in the propagation the tree sexually is that its seeds show seed coat dormancy (Anozie and Oboho, 2019). The seed is characterized by a very hard outer shell resembling a coconut shell which inhibits its uptake of water and oxygen for germination. This makes natural regeneration of the species extremely difficult. Seeds remain quiescent in the ground for a very long time, placing seedlings at a competitive disadvantage if germination eventually occurs. The development of an efficient protocol for its propagation would be an incentive for tree growers to adopt the cultivation of this species. Seed coat dormancy can be broken by using various scarification methods: hot water (Baskin, *et al.*, 2004), dry heat (Mott, *et al.*, 1982), long-term dry storage (Morrison, *et al.*, 1992), warm moist incubation (Jayasuriya, *et al*., 2007), and acid (Baskin and Baskin, 2014). However, there exist significant interactions between scarification method and species diminishing universality of the method. The objective of this study was to test the influence of different pre-treatments on germination of *C. schweinfurthii*. Given the importance of root growth on early growth survival of forest trees, the response of this trait to pre-treatment was also evaluated.

Materials and Methods

Seed source

The seeds used for the study were collected from *C. schweinfurtheii* trees in Bambili, one of the four main villages that make up Tubah Sub-Division, Mezam Division, North West Region of Cameroon. Its geographical coordinates are latitude 5º 59′ N of the equator and longitude 10º 15′ E of the Greenwich meridian. The climate of Bambili is of tropical monsoon type. The rainy season runs from March to October while the dry season extends from October to March. With an average annual precipitation of 2095 mm, the most rainfall occurs from July to September. The mean annual temperature is 22.51 °C.

Experimental Site

The experiment was conducted at the Reforestation Task Force (RETAFO) nursery located at Mile 6 Nkwen in Bamenda III Sub-division. Bamenda III is one of the subdivisions of the Bamenda council area in Mezam Division. Nkwen is located at 5° 59′ N, 10° 11′ E. It is characterized by two seasons (dry season: mid-October to mid-March; wet: mid-March to mid-October. In Bamenda, rainfall is between 2000 and 3000 mm per year and the average annual temperature is 19.3 °C. The area is characterized by strong winds and a cover of heavy clouds that descend from the hills.

Experimental Design

The experiment was comprised of the following five pre-sowing treatments: control, warm water, acid, dry heat @ 100 °C, and dry heat @ 60 °C. The experiment was carried out in a non-mist propagator constructed as a wooden box sealed with a leak proof heavy-duty polythene film. It was partitioned into three compartments measuring 1 m long × 1 m wide × 0.25 m deep. Each compartment was further divided into 5 sub-units of equal dimensions and filled with soil. Each of the sub-units corresponded to a pre-treatment. A wooden frame extending from the corners of the propagator was enclosed in polythene that was fastened to the box to keep the micro-environment of the propagator humid. A shutter was created at the upper surface of the frame for replenishing water in the substrate and monitoring the progress of the experiment.

On 7 December 2022, the warm water, acid, and dry heat @ 60 °C were administered to the seeds after which they were planted in the propagator. The warm water treatment was administered by immersing the seeds in a plastic bucket containing water at 60 ˚C for 2 hours. As for the acid treatment, the seeds were soaked in dilute HCl in a bowl for 2 hours. The dry heat @ 100 °C was achieved by heating seeds in an oven for 2 hours. To ensure that the planting was done at the same time for all the pre-treatments, the dry heat @ 60 °C treatment had been started the previous day since it required oven-heating for 24 hours. Seeds in the control treatment level were planted without any pre-sowing treatment. The soil was saturated with water prior to the sowing of the seeds. There were 50 seeds in each of the pre-sowing treatments that was replicated thrice. The propagator was situated in a shade house roofed with alternating rows of transparent plastic and corrugated iron roofing sheets. Irrigation was done as needed. Any weeds emerging from the soil were removed by hand.

Data collection

The number of seeds that germinated were recorded. When there was no further germination for a period three weeks in any pre-treatment, the process was considered complete and the experiment was terminated. The following parameters were calculated:

$$Final\ Germination\ Percentage\ (FGP) = \frac{SG}{TP} \times 100$$

Where SG = seeds germinated, and TS = total seeds planted.

$$Mean\ Germination\ Time\ (MGT) = \Sigma(n\ \times d)/N$$

Where n = number of seeds germinated on each day, d = number of days from the beginning of the test, and N = total number of seeds germinated at the termination of the experiment. The MGT represents the mean time a seed lot requires to initiate and end germination (Orchard, 1977).

$$Germination\ Rate\ Index\ (GRI) = [(G_1/1) + (G_2/2) + (G_3/3) + \ldots + (G_x/X)]$$

where G = germination on each day after sowing; 1, 2, 3, X = corresponding day of germination. The index reflects the percentage of germination on each day of the germination period (Maguire, 1962).

Data analysis

The data were examined for homoscedasticity and normality using histograms and normal probability plots before being subjected to one-way ANOVA untransformed. When the results of the ANOVA was significant for a particular parameter, means separation was conducted with Tukey LSD. All the tests were run in Data desk 6.0 at α = 0.05.

Results

There were significant effects of pre-sowing treatment on all the three germination indices examined (Table 1).

Table 1: ANOVA p-values for the effect of pre-sowing treatment on germination and root growth

Source	FGP	MGT	GRI
Pre-treatment	≤ 0.0001	≤ 0.0001	≤ 0.0001

FGP = Final Germination Percent; MGT = Mean Germination Time; GRI = Germination Rate Index

Values of Final Germination Percentage (FGP) were lowest for the two dry heat treatments which were not statistically different from each other (Fig. 1). On the other hand, FGP significantly increased from warm water to the control. However, differences between the former and either the control or acid pre-treatments were not statistically significant (Fig. 1).

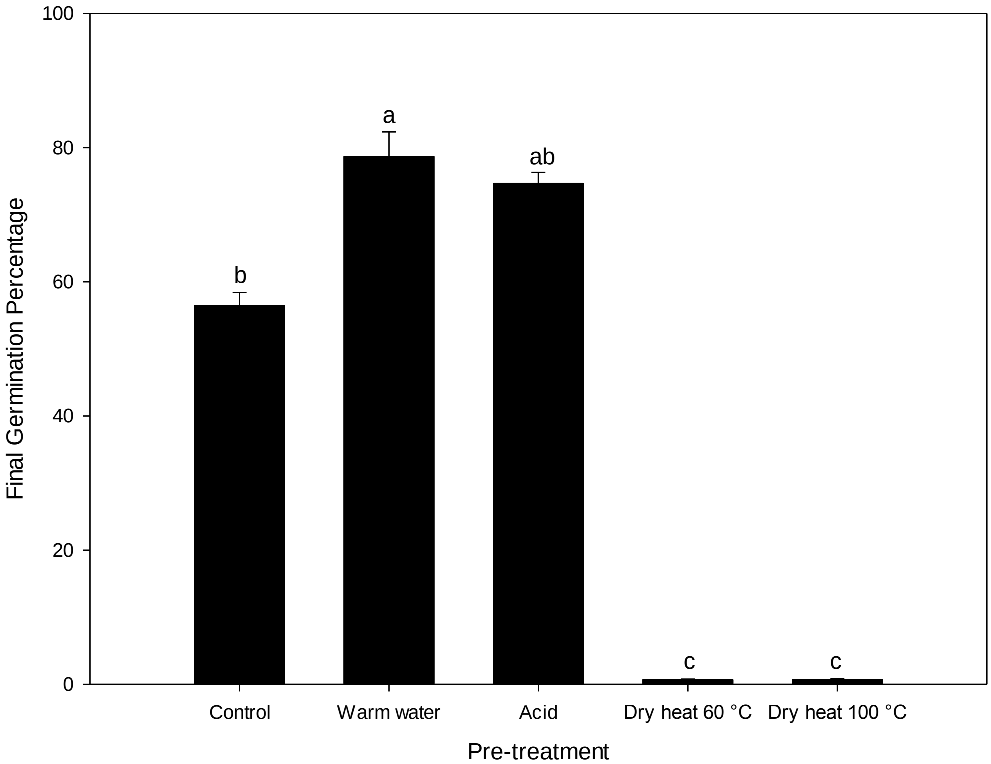

Figure 1: Effect of pre-sowing treatment (Mean ±SE) on Final Germination Percentage. Means bearing the same letter are not significantly different from one another.

Mean Germination Time (MGT) was highest for warm water and lowest for dry heat @ 100 °C. The trait responded to dry heat @ 60 °C in a similar manner as it did to dry heat @ 100 °C. MGT declined from the control to acid pre-treatment (Fig. 2).

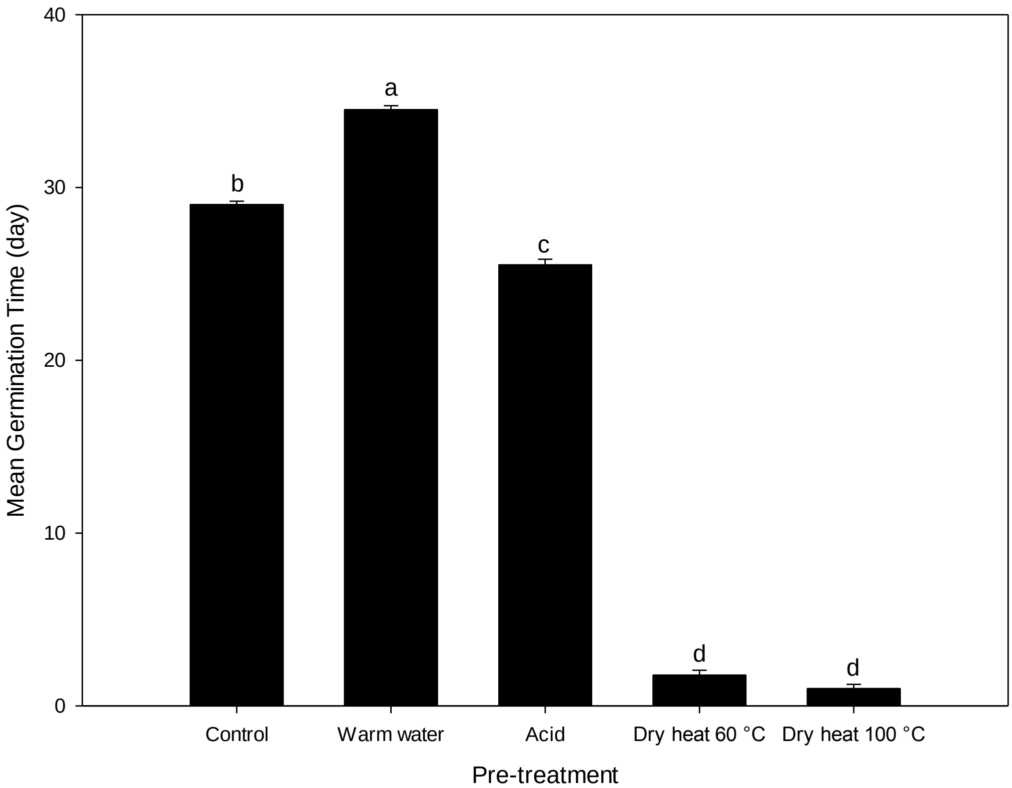

Figure 2: Effect of pre-sowing treatment on Mean Germination Time. See caption of Figure 1 for other explanations.

Similar to the other two germination indices, the oven-heating of seeds suppressed Germination Rate Index (GRI) to the extent that the magnitude of response were lowest in the dry heat pre-treatments (Fig. 3). Dry heat @ 60 ° C and 100 °C resulted in similar values of the parameter. In contrast, GRI decreased from the acid to the warm water pre-treatment. The post-hoc test detected differences between warm water and the control to be insignificant (Fig. 3).

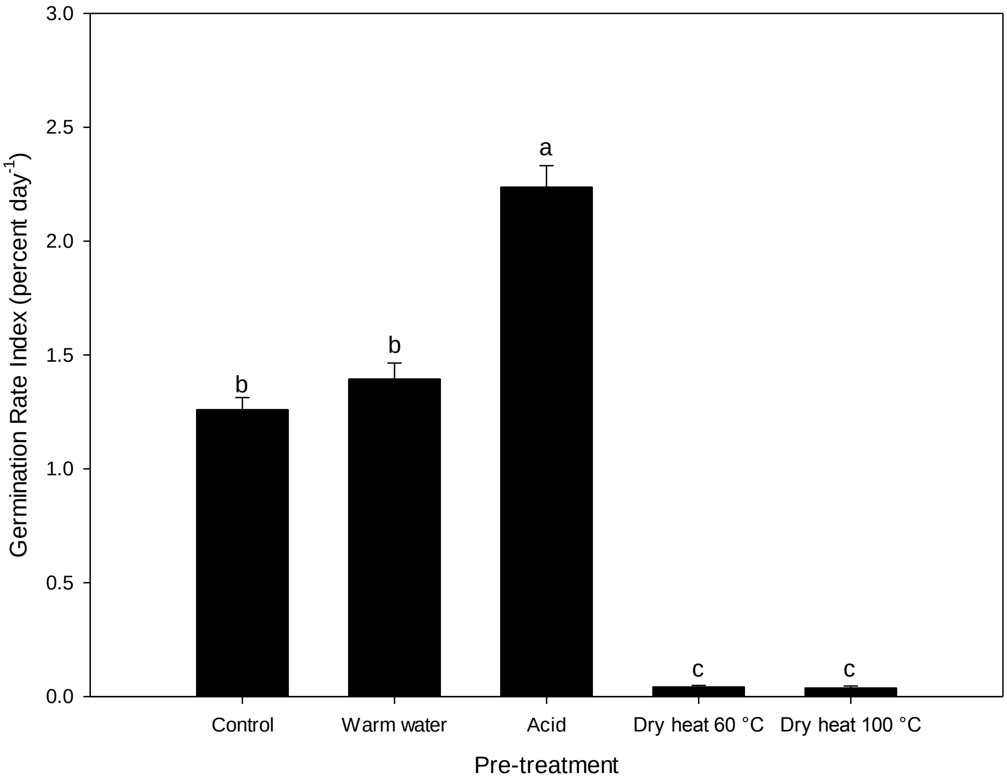

Figure 3: Effect of pre-sowing treatment on Germination Rate Index. See caption of Figure 1 for other explanations.

Discussion

The results of this study have shown that warm pre-sowing treatment of *Canarium schweinfurthii* seeds is beneficial to germination. A similar observation had been made in other studies where seeds of *C. schweinfurthii* (Anozie and Oboho, 2019) and *C. resiniferum* (Hasnat, *et al.*, 2017) were soaked in warm water for 4 hours. Interestingly and as found in the current study, reducing the soaking time by half yields the same outcome for *C. schweinfurtheii*. Exposing seed to water at high temperature for prolonged period of time may destroy the embryo. As a form of thermal scarification, the important role of warm water in breaking physical seed coat dormancy is imparted by inflicting cracks in seed coat; the anatomy of the micropyle is left unaltered in the process (Rusdy, 2017). The cracks breaks the physical barrier, allowing the entry of water and oxygen into the seed to activate metabolic processes for germination (Baskin and Baskin, 1999). Hot water treatment has also been found to enhance the release of germination inhibitors from tropical tree seeds (Sharma, *et al.*, 2008).

As observed in this study, acid scarification can be a useful alternative to warm water pretreatment for breaking seed coat dormancy in *C. schweinfurtheii* as both treatments resulted in similar FGP. Additionally, the incubation of seeds in HCl accelerated the germination with the outcome that the time from initiation to termination of germination was markedly reduced. The highly significant influence of acid treatment on rate and average time germination has been reported by other researchers (Alaba, *et al.*, 2011; Nasr, *et al.*, 2013; Musara, *et al.*, 2015; Khehfoluli, *et al.*, 2017). According to Baskin (2003), the HCl pre-treatment of *C. scheinfurteii* seeds likely reduced the thickness of several lignified layers in the testa, which are packed tightly together and contain water repelling compounds, which pose a physical barrier to water absorption and gaseous exchange (Colling, 2009). As noted by Baskin and Baskin (2014), reducing the coat thickness is an important driver for treating seeds before sowing to enhance germination as the uptake of water and respiratory gases is favoured.

As determined from our investigation, oven-drying seeds of *C. scheinfurteii* at the temperatures and durations tested is not beneficial to germination. Instead of causing the seed coat to develop cracks, this form of thermal stratification rather dehydrated the seed to an extent that enzyme activation was adversely affected (Chayjan, *et al.*, 2013). Moreover, drying may further harden the seed coat, making permeableability even more difficult. The germination under the dry heat treatments progressed rather slowly and to a very small extend was terminated in a very short period of time.

Conclusion

It is concluded from this investigation that physical dormancy in the seeds of *C. scheinfurtheii* can be broken by the warm water and HCl treatments, leading to comparable germination percentages. In contrast, the use of dry thermal scarification may be detrimental as all germination parameters showed responses far below the control for the two pre-treatments under this category.

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