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Effects of pre-sowing treatments on the germination and early growth performance of *Pouteria campachiana*

O. A. Amoakoh ^a, D. D. N. Nortey^a, F. Sagoe^b, P. K. Amoako^c and C. K. Jallah^d

^aHen Mpoano (Our Coast), Takoradi, Ghana; ^bTimber Industry Development Division, Forestry Commission, Accra, Ghana; ^cCocoa Health and Extension Division, Ghana Cocoa Board, Accra, Ghana; ^dCollege of Agriculture, Cuttington University, Bong County, Liberia

ABSTRACT

Pouteria campachiana is a multipurpose fruit tree with diverse economic and medicinal significance. However, seed dormancy and low germination are problems for its use in agro-forestry practices. Investigations were carried out on the effect of pre-treatment on the germination and early seedling growth of *P. campachiana*. Germination was observed in seeds pre-treated with soaking and mechanical scarification in the 5th week after sowing, while untreated seeds germinated in the 7th week. Comparison between mechanically scarified and unscarified *P. campachiana* seeds showed no significant difference ($P > 0.05$). The study showed that soaking *P. campachiana* seeds in cold water was not good for its germination, with a significant difference between soaked seeds and non soaked seeds. Percentage germination of seeds not soaked was 62.2% compared to 26.7% and 24.4% recorded for seeds soaked for 24 h and 48 h, respectively. The application of different pre-treatments, however, had no significant ($P > 0.05$) influence on the mean shoot length, collar diameter, and the number of leaves of *P. campachiana*. The study concludes that mechanical scarification improves germination of *P. campachiana* while soaking with cold water has a negative influence on seed germination.

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Germination; growth parameters; pre-treatment; *Pouteria campachiana*; seeds

Introduction

Pouteria campachiana (Baehni) is a woody tree of the family Sapotacea (Morton 1987). The mature tree grows up to 30 m in height and 1 m in diameter. Fruits are green-skinned, hard, with gummy internal tissue when unripe. Ripe fruits are lemon-yellow, golden-yellow, or pale orange-yellow skinned (Morton 1987).

Pouteria campachiana is a native plant of southern Mexico, Belize, Guatemala, and El Salvador. It can be found distributed throughout Central America, the Caribbean, South East Asia, and Africa (Morton 1987). In Ghana the tree is common in Aburi in the Eastern Region.

The tree has fine-grained timber that is compact, strong, moderate to very heavy in weight, and hard, with value especially for planks, rafters in construction, and firewood (Morton 1987). *Pouteria campachiana* is rich in niacin and carotene (pro-vitamin A) and has reasonable levels of ascorbic acid, protein, fibre, carbohydrate, calories, thiamine, moisture, phosphorus etc (Morton 1987).

A decoction of the astringent bark is taken as a febrifuge in Mexico and applied on skin eruptions in Cuba. A preparation of the seeds has been employed as a remedy for ulcers and extracts from the tree have been used to adulterate chicle in Central America (Morton 1987).

Seed germination is one of the main difficulties in propagating *P. campachiana*. The cause is attributed to the intense suffering latency, which may be due to undeveloped embryo, thick covering of the seed that interferes with the absorption of water and oxygen, and resistance to the growth of the embryo (Roth et. al. 1972). According to De Leon (1968), seeds of these fruits take longer to germinate and often lose their viability as they age because, with the passage of time,

the embryo shrinks from lack of moisture, so the germination stage takes longer because it has to absorb water to return to its original proportions.

Overcoming seed dormancy would improve the trees' regeneration potential and make it an ideal plant for agro-forestry and sustainable livelihoods due to its numerous economic and medicinal uses. This study therefore sought to assess the impact of pre-sowing treatment on the germination and early growth performance of *P. campachiana*.

Materials and methods

Planting materials and study site

Mature seeds of *P. campachiana* were collected and the experiment was carried out at the Plants Genetics Resources Research Institute (PGRRI) of the Council for Scientific and Industrial Research (CSIR), Bunso, Eastern Region, Ghana (5°46'N, 1°1'W). Temperatures in the region vary from 24 °C to c. 28 °C and mean annual rainfall is 1750 mm.

Seed treatments

Matured seeds of *P. campachiana* were treated by mechanical scarification and soaking. Table 1 details the seed treatment techniques used in the study.

Experimental design

The experiment was laid out using the completely randomized design (CRD). There were nine treatments and three replications. A total of 30 seeds were sown for each treatment. This is represented in Table 2.

Table 1. Seed treatment and description.

Seed treatment	Description
Seed coat partially scarified	One-third of the seed coat was removed with a sharp knife.
Seed coat completely scarified	All the seed coat was completely removed using a sharp knife.
Seed soaking	Seeds were soaked in cold tap water in a plastic bowl and kept in a cool dry place at a temperature of 25 °C. The soaking periods were 24 h and 48 h. Seeds were sown after the soaking period.
Control	Seeds for control experiment were not scarified at the first level Seeds for control experiment were not subjected to soaking treatments at the second level.

Table 2. Nine pre-sowing treatments.

Seeds	Treatments		
	No soaking(control)	24 h soaking	48 h soaking
Control	30 seeds	30 seeds	30 seeds
Partially scarified	30 seeds	30 seeds	30 seeds
Completely scarified	30 seeds	30 seeds	30 seeds

Germination percentages

Germination was observed for 12 weeks and the number of seeds germinated in each treatment was recorded on a weekly basis. Germination was observed in the seeds when the first radicle emerged. At the end of the germination period, the germination percentage was calculated using the following equation by Maguire (1962):

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated} \times 100}{\text{Number of seeds on tray}}$$

Growth parameters

Growth parameters such as shoot length, collar diameter, and number of leaves were assessed 12 weeks after sowing. Electronic digital calipers (6"/150 mm, accuracy ± 0.02 mm, LR44, 2006/66/EC) were used to measure stem diameter and total shoot length (from the apical bud of the plant to the base of the shoot).

Statistical analysis

The data obtained for seed germination percentage were statistically analysed using the analysis of variance (ANOVA) procedure of SAS 9.2 software package and the means of the shoot length, collar diameter, and number of leaves were analysed using Tukey's HSD multiple comparison test.

Results

Germination trends

Percentage germination was highest (67%) among seeds treated with partial scarification followed by completely scarified seeds (63%) and then untreated seeds (57%). Percentage germination of seeds soaked ranged between 20% and 30%. Germination started in the 5th week in the case of soaked and mechanically scarified seeds while the untreated seeds started germination in the 7th week (Figures 1–3).

Mechanical scarification of *Pouteria campachiana* seeds

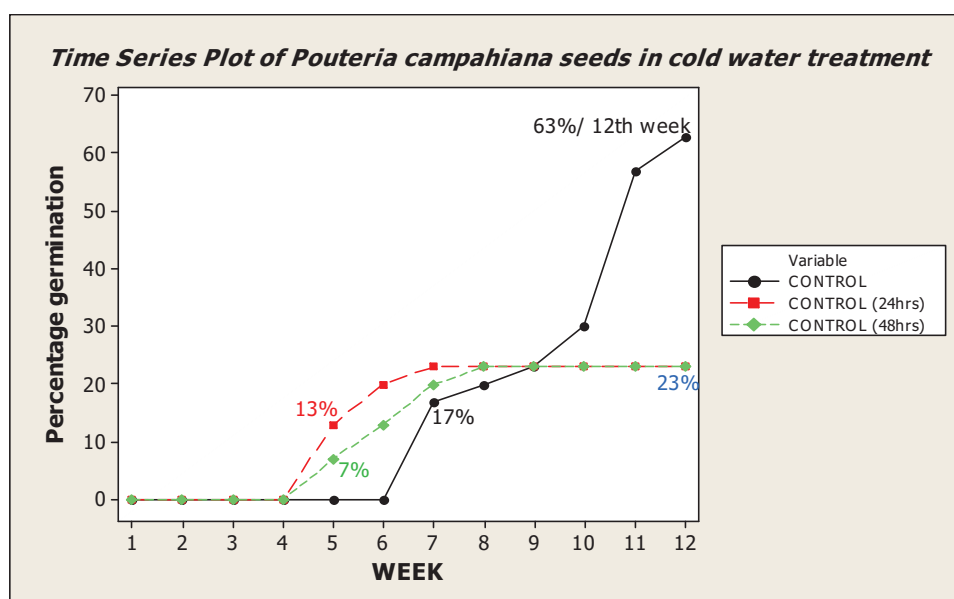
Comparison between mechanically scarified and unscarified *P. campachiana* seeds showed no significant difference ($P > 0.05$).

Soaking *Pouteria campachiana* seeds

The result showed that soaking *P. campachiana* seeds in cold water was not good for germination. Table 3 shows a significant difference between soaked seeds and non soaked seeds. Percentage germination of non soaked seeds was 62.2% against 26.7% and 24.4% recorded for seeds soaked for 24 h and 48 h, respectively (Table 3).

Seedlings growth performance

The application of different pre-treatments had no significant ($P > 0.05$) influence on the mean shoot length, collar diameter, and the number of leaves of *P. campachiana* (Tables 2–4).

**Figure 1.** Trend of germination of unscarified *Pouteria campachiana* seeds soaked for 24 h and 48 h.

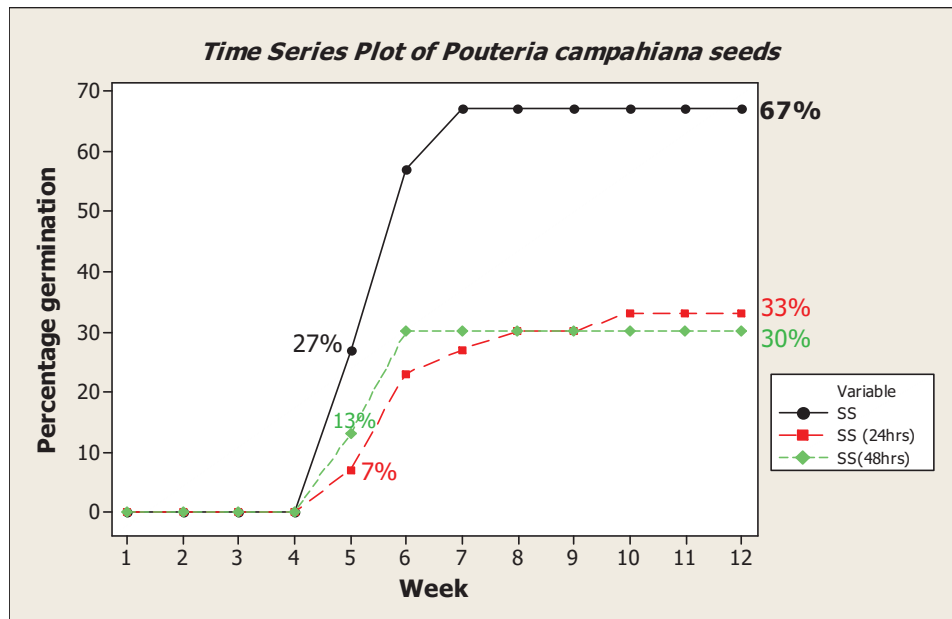


Figure 2. Trend of germination of partially scarified *Pouteria campachiana* seeds soaked for 24 h and 48 h.

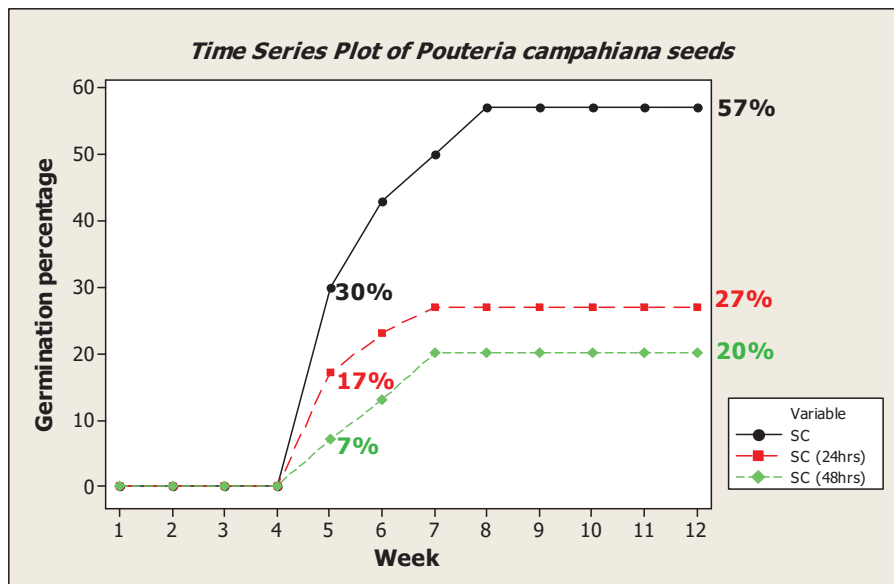


Figure 3. Trend of germination of *Pouteria campachiana* seeds whose shells are completely removed and soaked for 24 h and 48 h.

Table 3. Effect of soaking in water at room temperature on the germination, seedling height, and diameter of *Pouteria campachiana*.

Treatments	Number of seeds germinated (%)	Mean seedling height (cm)	Mean seedling diameter (mm)	Mean number of leaves
Control	62.2 a	13.744 a	2.677 a	6.067 a
1 day (24 h)	26.7 b (-57.07)	17.678 a (+28.594)	2.544 a (-4.968)	6.611 a (+8.967)
2 days (48 h)	24.4 b (-60.77)	16.822 a (+22.395)	2.167 a (-19.051)	5.911 a (-2.571)
SD	2.24	6.507	1.030	2.920
SE	0.43	1.257	0.198	0.562
P-value	0.000	0.419	0.569	0.876
R	0.701	0.197	-0.206	-0.022
R ²	0.491	0.039	0.043	0.000

Notes: Values with the same letter(s) within a column are not significantly different at P = 5% (0.05) by Tukey's HSD multiple comparison test. Data in parenthesis indicate % reduction (-) or increase (+) over control.

Discussion

Different approaches of breaking seed dormancy in order to enhance germination rate and increase the germination process have been suggested by many authors (Airi et al. 2009; Azad et al. 2010). These include physical scarification of the seed coat by nicking, piercing with needles and knives, and/or using abrasion paper (Schmidt 2000). Methods such as cold water soaking can also be used to overcome physical seed dormancy (Sabongari 2003). Hossain et al. (2005) reported that seeds with hard, solid, impermeable seed coats were noted to establish germination after pre-sowing treatments. However, breaking of seed dormancy varies from species to species. Therefore, it is very important to determine which method and condition is suitable for each plant species.

Table 4. Effect of mechanical scarification on the germination and early growth of *Pouteria campachiana*.

Treatments	Number of seeds germinated (%)	Mean seedling height (cm)	Mean seedling diameter (mm)	Mean number of leaves
Control	36.67 a	13.833 a	2.044 a	4.744 a
Partially scarified	42.22 a (+15.135)	16.878 a (+22.126)	2.667 a (+30.479)	6.889 a (+45.215)
Completely scarified	34.44 a (-6.081)	17.533 a (+26.748)	2.678 a (+31.018)	6.956 a (+46.627)
SD	24.24	6.507	1.030	2.920
SE	0.431	1.252	0.198	0.562
P-value	0.765	0.454	0.341	0.192
R	-0.103	-0.195	-0.251	-0.305
R ²	0.011	0.038	0.063	0.093

Notes: Values with the same letter(s) within a column are not significantly different at $P = 5\%$ (0.05) by Tukey's HSD multiple comparison test. Data in parenthesis indicate % reduction (-) or increase (+) over control.

The findings of this study showed that, although untreated *P. campachiana* seeds achieved impressive germination at the end of the 12th week, the mechanically scarified and soaked seeds germinated earlier than the control (Figures 1–3). The fact that mechanical scarification gave earlier germination indicates that the more rapidly the seed coat is ruptured, the faster the rate of germination. This is more so, since a very widespread cause of seed dormancy is the presence of hard seed coats which prevents the entrance of water, exchange of gases, and/or mechanically constrain the embryo (Mayer and Maber 1963). There was no significant difference between the control and the mechanically scarified seeds either in the percentage germination or the growth parameters considered.

The effect of cold water on seed germination gave a result contrary to what would be expected as it impeded germination. About 24%–27% of the soaked seeds germinated and this was significantly different to the 62% recorded for the control (Table 3). This shows that cold water pre-treatment is not an appropriate pre-treatment technology for *P. campachiana*. This is in tandem with the observation of Robertson and Small (1977) that over-soaking seeds in water may reduce germination through oxygen deficiency. The result was, however, contrary to the findings by Owonubi et al. (2005) that soaking *Azadirachta indica* seeds for 1 h and 12 h resulted in increased rates of seed germination. This implies that different species have varying rates at which their seed coat is permeable to water and gases (Owonubi et al. 2005). The *P. campachiana* seeds might contain some chemicals that assist germination which could be leached out by soaking overnight. The observation could also be due to the fact that the seed coat might have contained some deposition of fat/oil which delayed/prevented the water from penetrating, so affecting the germination process.

Ibrahim and Otegbeye (2004) found in their study of *Adansonia digitata* that soaking seeds for 1 h, 12 h and 24 h resulted in increased rates of seed germination. The different observation obtained in this investigation with *P. campachiana* therefore indicates that the efficiency or otherwise of treating seeds by soaking in water depends very much on the seed coat (testa) characteristics.

Conclusion

Mechanical scarification of *P. campachiana* seeds improves germination. Though the study revealed no significant difference between mechanically scarified seeds and untreated seeds it is worth noting that germination started on the 5th week compared to the 7th week observed in the case of untreated seeds. Soaking, whether for 24 h or 48 h, was identified not to be a good pre-treatment technique for *P. campachiana* seeds.


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Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

O. A. Amoakoh  <http://orcid.org/0000-0001-8394-1241>

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