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Effects of Different Treatments on Seed Germination and Improvement of *Vitellaria paradoxa*

A. Muhammad[1*], S. Sale[1], Z. A. Abubakar[1], A. I. Abubakar[1], A. Babale[1], A. Bappi[2]

[1]Department of Botany, Faculty of Science, Gombe State University, Gombe, Nigeria
[2]Department of Geography, Faculty of Science, Gombe State University, Gombe, Nigeria
Email: *muhammadforall99@gmail.com

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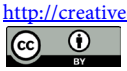

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Abstract

Shea butter (*Vitellaria paradoxa*) tree is one of the most important tree species in Africa owing to its high potential in reduction of poverty and hunger in rural areas and enhancing environmental sustainability. All parts of shea tree are important from bark to wood and from leaves to fruits. Despite all the uses and many more, shea is amongst the endangered species of trees because of over-utilization, low regeneration abilities and lack of efficient propagation methods. Consequently, this research seeks to determine the most efficient methods for propagating *V. paradoxa*. The experiment consists of three stages. In the first stage, complete fruits were planted without depulping; in the second experiment, the seeds were exposed to single seed treatments that were applied to the seeds and in the third experiment, the seeds were exposed to double seed treatments. It was observed that intact fruits did not germinate while the results showed the single seeds treatment to significantly have affected germination performance. De-shelled seeds germinated faster (43 days) than all other treatments but 48 hours soaking produced the highest germination percentage (91.7%). An even better result was recorded with double seeds treatments in which de-shelled plus 24 hours soaked seed germinated faster (39.3 days) than other treatments while sandpapered plus 24 hours soaked seeds had the best germination percentage (75%). Therefore, scarification using sandpaper plus soaking for 24 hours was identified as the best treatment for breaking seed dormancy in *V. paradoxa*.

Keywords

Vitellaria paradoxa, Germination, Seeds Treatment, Regeneration

1. Introduction

Shea butter tree (*Vittellaria paradoxa* C. F. Gaertn) is one of the most important tree species in Africa owing to its high potential in reduction of rural poverty, hunger and enhancing environmental sustainability [1] [2]. The fruit pulp has excellent nutritional content and is widely consumed among indigenous people of Africa [3]. The increasing popularity of the butter in cosmetics, the world over is attributed to its own skin protecting and curing properties [4]. However, of the peculiar characteristics of the species include its slow emergence speed [5] and [6], slow growth rate and long gestation period. *V. paradoxa* germination starts with the cracking of the testa at the blunt end of the nut and coming out of the false or apparent radicle. This apparent radicle is positively geotropic, curve beneath the nut before penetrating into the soil. A pink colored shoot with scale leaves emerges and grows upward. The poor germination and plumule growth in shea have been attributed respectively to seed dormancy and rapid fall in viability [7]. Any pre-sowing treatment that can reduce loss in viability and facilitate substrate mobilization should potentially increase the germination and emergence percentages as well as reduce the time to plumule emergence and enhance faster seedling development. Since information on effective pre-treatment methods of breaking seed dormancy in shea butter seed and enhancing early growth remain critical to raising economic quantities of seedlings in nursery [8]. This study therefore seeks to investigate the most effective and efficient pre-treatments methods to break the seed dormancy in shea butter seeds and also evaluate the possibility of effective propagation of the plant.

2. Materials and Methods

The experiments were carried out at the Department of Biological Sciences Botanic Garden, longitude 10˚18.283'E, latitude 11˚10.601'N, Gombe State University (**Figure 1**). Matured fruits of *V. paradoxa* from good phenotypic mother trees in their natural assemblage were collected by picking freshly fallen ones from the vegetation floor and were separated into batches for treatment. Mixtures of sand, loam and humus soil was collected into perforated poly pots and were filled to about 3/4. The experiments consist of three stages of treatment. Intact fruits as a first experiment (control treatment), single pre-treatments method on seeds as second experiment and double pre-treatments methods as third experiment on seeds. In the first stage, freshly collected fruits (intact) were sown in poly pots without any pre-treatment method. The second stage consist of depulped seeds, some of which were soaked in water for 24, 48 and 72 hrs respectively, some batch of seeds were scarified manually by sand paper, some were cracked gently, taking care not to damage the seeds, some seeds were deshelled and intact seed as control. Last stage of experiment involved sand papering plus soaking, cracking plus soaking and deshelling plus soaking of seeds for 24, 48 and 72 hrs respectively. Treated seeds were sown in poly pots which were thoroughly watered before and immediately after sowing in a Complete Randomized

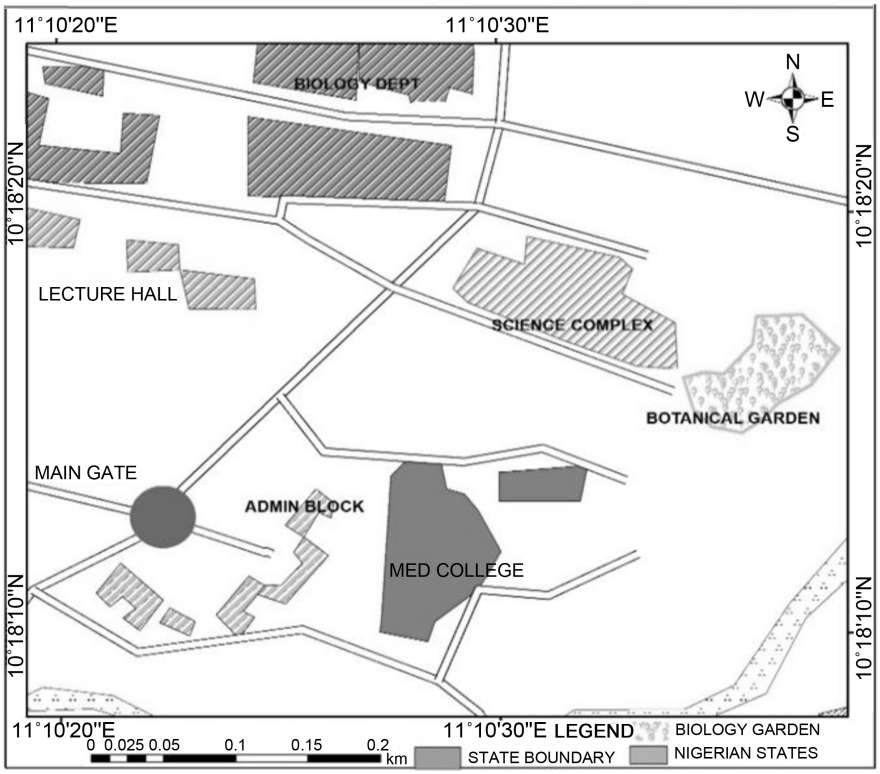

Figure 1. Map of gombe state university showing the location of the botanical Garden.

Design (CRD). The data obtained was analyzed using Analysis of Variance (ANOVA) and simple percentages.

3. Results

1) Effects of Fruit Pulp on Seed Germination in *Vitellaria paradoxa*: The results from the first experiment showed that fruit pulp prevented germination in *Vitellaria paradoxa*. All intact fruits with pulp did not germinate.

2) Effects of Single Treatment on Seed Germination in *Vitellaria paradoxa*: The results indicated that there was significant difference between the treatments ($p < 0.05$) with respect to germination period (Table 1). De-shelling was the most effective treatment with the least germination period (43 days) followed by sandpapered (48.6 days). Cracked seeds took the highest time to germinate (63.3 days) more than the control (57.0 days) (Table 1).

The results further showed that soaking for 48 hours had the highest germination percentage of 91.7% followed by sandpapered with 75%. Cracked seeds had the least percentage (16.7%) germination than the control (intact fruits) had a germination percentage of 33.3%l (Figure 2).

3) Effects of Double Treatment on Seed Germination in *Vitellaria paradoxa*: The results of the double treatment effects showed improved performance, with significant difference ($p < 0.05$) between the treatments, in comparison with the single treatment effects. Combining two treatments on the same seeds produce even better results in terms of germination rates. De-shelling plus

Table 1. Effects of single treatment on the germination period of *Vitellaria paradoxa* seeds.

S/N	Treatments	Means (days) ± Std. error
1	24H Soaking	54.66 ± 3.93^{ab}
2	48H Soaking	55.33 ± 4.26^{ab}
3	72H Soaking	51.00 ± 3.79^{bc}
4	Sandpapered	48.66 ± 3.67^{bc}
5	Cracked	63.33 ± 1.45^{a}
6	De-shelled	43.00 ± 0.58^{c}
7	Control	57.00 ± 3.46^{ab}

Key: H-hours; Different letters indicate significant differences between treatments; Std. Error-standard error of means.

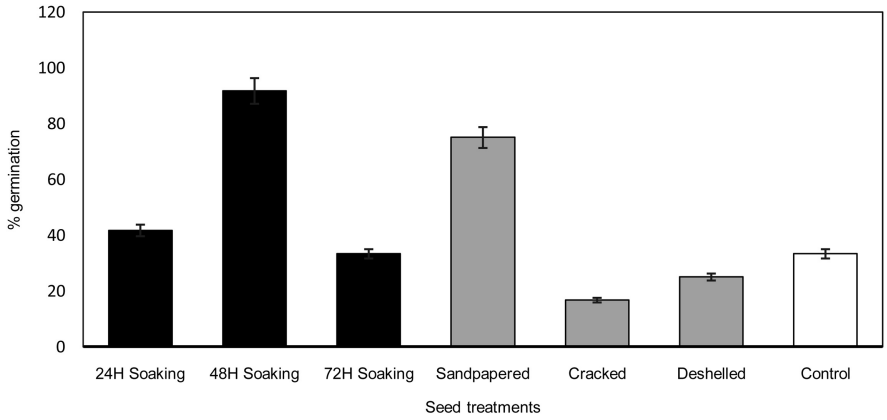

Figure 2. Percentage germination of *Vitellaria* seeds with single treatment.

soaking for 24 hours is the most effective treatment with least germination period (39.3 days), but does not significantly differ with sandpapered plus soaking for 24 and 48 hours. The highest germination period (58 days) was recorded in de-shelled plus 48 hours soaked seeds (**Table 2**).

Combining two different treatments produced higher germination rate without significantly affecting germination percentage. Sandpapered plus 24 hours soaking had the highest germination percentage (75%) followed by sandpapered plus 48 hours soaking (58.3%) while de-shelling plus 72 hours soaking had the least percentage germination (8.3%) (**Figure 3**).

4. Discussion

The result of the first experiment has shown that fruit pulp prevented germination in *V. paradoxa*. This is because there is a layer of waxy, thick and semi-water-proof sheath attached to the seed coat that separate the seed from the fruits. This layer probably prevented water from reaching the seed coat and subsequent absorption by the endosperm before the seed got rotten or lose its viability. This perhaps is due to the fact that *Vitellaria* seeds lose their viability shortly after detached from mother trees [9]. This also explains the reason why

Table 2. Effects of double treatment on the germination period in *Vitellaria paradoxa.*

S/N	Treatments	Means (days) ± Std. error
1	SP + 24 H Soaking	39.67 ± 0.33[b]
2	SP + 48 H Soaking	41.33 ± 1.86[b]
3	SP + 72 H Soaking	45.67 ± 3.18[ab]
4	Cra + 24 H Soaking	52.67 ± 6.67[ab]
5	Cra + 48 H Soaking	47.33 ± 0.89[ab]
6	Cra + 72 H Soaking	51.00 ± 5.57[ab]
7	Desh + 24 H Soaking	39.33 ± 0.33[b]
8	Desh + 48 H Soaking	58.00 ± 2.31[a]
9	Desh + 72 H Soaking	56.67 ± 7.42[a]

Key: SP = sandpaper, H = hours, Cra = cracked, Desh = de-shell, H-hours; Different letters indicate significant differences between treatments; Std. Error = standard error of means.

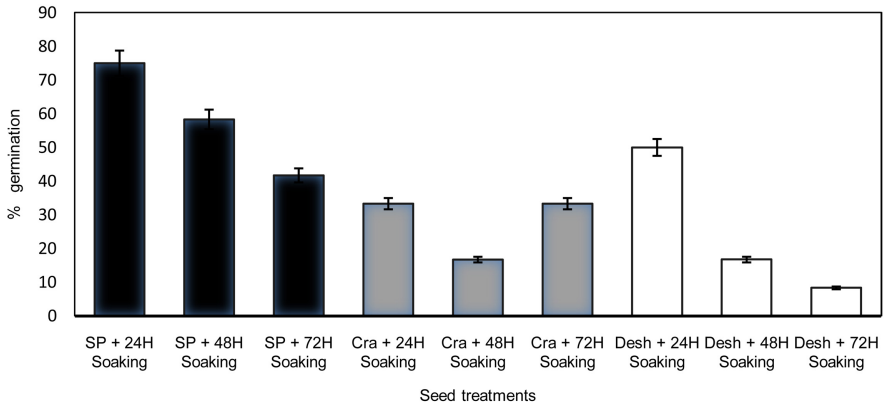

Figure 3. Percentage germination of *Vitellaria* seeds with double treatment. Key: SP = sandpaper, H = hours, Cra = cracked, Desh = de-shell.

there is low natural regeneration abilities associated with Vitellaria [6].

The results of single treatment showed significant effect on germination performance in *Vitellaria paradoxa*. The de-shelled or de-coated seeds germinated faster than all other treatments. This is due to the fact that the endosperm received water and oxygen easily which enhanced physiological activities necessary for germination. Similar observation was reported by [10], that removal of seed coat enhances germination. Even though de-shelled seeds germinated faster, their germination percentage is less compared to other treatments. This may be due to the negative effects of de-shelling on seed physiology.

The results also showed that sandpapered seed had high germination rate. This, maybe, was because the thickness and strength of the seed coat was reduced significantly by scarification, which allowed water to permeate the seed easily. In addition, sandpapered seed had very high germination percentage (75%) probably because, unlike de-shelling, sandpapering did not harm the inner part of the seed. This result is similar to that of [11] which showed that germination percentage of *V. paradoxa* was significantly high when seeds were sca-

rified around the circumference and at the microphyle by filing. It also in agreement with the work [12] and [13].

Results from single treatment also revealed that there was no significant effect of cracking the seed coat on germination period. Cracked seeds did not germinate faster (63.3 days) compared with the control and they also had the least germination percentage (16.7%). This is because the process of cracking might not have reduced the restraining effects of the coat. This finding corresponds to the results of [14] who stated that cracked seeds of *V. paradoxa* took 67 days to germinate, but differed with the work of [11] who found that cracked seeds of *V. paradoxa* took fewer days to germinate.

Furthermore, soaking of seeds for 24 and 48 hours did not significantly improve germination rate, but produced significant germination percentage. However, soaking seeds for 72 hours had slightly improved the rate of germination but had reduced germination percentage. This indicated that the period of seed soaking is directly proportional to rate of germination but inversely proportional to germination percentage. This is perhaps due to decrease in oxygen proportion when the proportion of water is increased in a given environment. [15] reported that oxygen deficiency can be fatal during germination. This agreed with the work of [11] who reported that 6hrs soaking of seeds significantly improved germination in *V. paradoxa*, and that of [16] on *Pouteria campachiana*.

The results revealed that double treatments significantly improved germination performance in *V. paradoxa* compared to the single treatment effect. Sandpapered plus 24 hrs soaked seeds germinated faster and had the highest germination percentage. This is the best treatment combination in this study. Similar result was reported by [17] that sandpaper and soaking treatment was found to be most effective for *Bixa orellana*, *Cassia angustifolia* and *Psoralea corylifolia*. This indicated that reducing the thickness and strength of seed coat followed by soaking allowed water to be absorbed easily and faster for the seeds to germinate before losing its viability. [18] reported that mechanically scarified seed with sand paper and soaked in tap water for 24 hrs has a significant impact on breaking the dormancy. There was an increase in days to germination when *V. paradoxa* seeds were soaked in water for 48 and 72 hrs after sand papering respectively but had least days to germination when compared to cracking plus soaking. This might be due to softening of seed surface and rapid imbibition of water by the embryo [19]. [20] propounded that sandpaper scarification is one of the most effective method in breaking dormancy in many species.

Double treatment results further indicated that de-shelling plus soaking for 24 hours of the *V. paradoxa* seeds showed faster germination than other treatments. It took 43 days for de-shelled seeds to germinate, but when combined with 24 hours soaking, they germinated in 39.3 days, a difference of about 4 days. Moreover, the percentage germination was also higher compared to control. However, when the time for soaking was increased to 48 and 72 hours after de-shelling, the germination period increased and germination percentage decreased. This may

be due exposure of embryo to too much water which might have affected some physiological responses within the cotyledon thereby affecting germination performance. Similar findings were reported by [10].

In addition, cracking plus soaking for 24, 48 and 72 hrs respectively have also significantly improved the rate of germination with 52.7, 47.33 and 51 days respectively compared with only cracking with 63.33 days. Similar result was reported by [14], that cracking plus soaking significantly improved germination performance in *V. paradoxa*. However, different result was observed when cracked nuts of *V. paradoxa* were soaked in Steinberge solution [14]. [8] observed that failure of cracked nuts to germinate was probably due to negative effects of excess water.

5. Conclusion

Understanding germination requirement of *V. paradoxa* is one of the most important steps in increasing the survival chances of the species. Findings of the present study revealed that failure of *V. paradoxa* seeds to regenerate naturally is caused by a layer of water-proof sheath attached to the seed coat and the hard and impermeable seed coat itself. A high level germination was observed by using traditional scarification technique of seed coat, thereby making it permeable to water and oxygen through various methods. It was found that mechanical scarification of seeds of *V. paradoxa* by sand paper in second experiment and sand paper plus soaking in water for 24 hrs in the third experiment were the most effective treatment methods. In conclusion, conventional pre-treatment technique by sandpapering plus soaking in water for 24 hrs is recommended for higher seed germination and fast regeneration of otherwise endangered species of *V. paradoxa*.

Acknowledgements

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Conflicts of Interest

The authors declare that there is no conflict of interest between them.

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