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Research Article
Circumventing the Menace of Seed Dormancy in Dormant Seeds of *Parkia biglobosa* and *Prosopis africana*

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Abstract

Background and Objectives: Crop production is hinged on the viability and productivity capabilities of planting materials such as seeds. Farmers are facing the challenge of breaking dormancy in some seeds which affects their production level. Thus, this present study was aimed at breaking seed dormancy in *Parkia biglobosa* and *Prosopis africana* using various methods with the view to determining the most efficient dormancy breaking methods. **Materials and Methods:** Dormant seeds of *Parkia biglobosa* and *Prosopis africana* used in this study were collected from Federal University of Agriculture, Abeokuta, Nigeria. The seeds were subjected to mechanical, chemical scarifications and hot water/heat methods while, the control was by soaking in ordinary water. **Results:** The results revealed that, the control (ordinary water) recorded null germination effect after 4 weeks. All other methods used in this study broke seed dormancy in the seeds of *Parkia biglobosa* and *Prosopis africana* except, for HCl scarification method. Highest amount of seed germination was recorded for the seeds of *Parkia biglobosa* treated with H_2SO_4. While, highest germination (%) was recorded in the seeds of *Prosopis africana* that was mechanically scarified. The results further indicated that dormancy is more severe in the seeds of *Prosopis africana* than that of *Parkia biglobosa*. **Conclusion:** Though, seed dormancy can be broken by natural events like bush fire and activities of some soil microorganisms, it is imperative to recommend that germination of seeds of *Parkia biglobosa* and *Prosopis africana* should employ artificial methods of dormancy breakage using any of the identified effective methods.

Key words: Dormancy, germination, menace, seed, scarification, *Parkia biglobosa*, *Prosopis africana*

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Germination of seeds occurs when seeds grow and survive to seedlings at a suitable time and place. The restriction of germination in unfavorable circumstances is described as dormancy. Dormancy is a period in an organism's life cycle when growth, development and physical activities are temporarily suspended. Dormancy occur, when there is a lack of germination in a seed/tuber even though the required conditions (temperature, humidity, oxygen and light) are provided[1]. Dormancy is a feature gained during evolution to survive in adverse conditions such as; heat, cold, drought and salinity. Dormancy enables some plant species to adapt to different geographical regions showing variations in precipitation and temperature[2]. Dormancy has a significant role in the development of new species and the successful dispersal of existing species[2].

Dormancy minimizes metabolic activities and therefore, helps an organism to conserve energy[3]. Physiologically, a seed which does not germinate when provided with adequate water, sufficient oxygen for normal aerobic metabolism and surrounding temperature is said to be dormant[4]. Seed dormancy is nature's way of setting a time clock that allows the seed to initiate germination when conditions are favorable for germination and survival of the seedlings.

The impermeable features of some plants seed coat (such as legumes) to water or gases and the mechanical restraint of the embryo are achieved by a combination of structural and/or chemical properties, which have been elucidated by anatomical and ultra-structural studies[5]. While the seed coat sometimes pose hindrance to uniform and rapid germination, it nonetheless performs the critical functions of regulating water uptake, providing a barrier to fungal invasion and reducing leakage from the embryo during imbibition. Ministry of Agriculture and Agrarian Reform[6] reported that 85% of the 260 Leguminosae seeds studied had a tegument totally or partially impermeable to water; and this was overcome by scarification, which is any treatment that results in the rupturing or weakening of the tegument, permitting the passage of water and the initiation of germination[7]. However, the nature of the high soil temperature may be responsible for the permeability of the water to coat the seeds of Fabaceae[8]. In nature, the lens may open in response to heating of the soil. The impermeability of the tegument is usually associated with the presence of one or more impermeable layers of palisade cells arranged in thick lignified secondary wall, being the most common are macrosclereids cells[2].

There are various degrees of dormancy varying from slight to very strong. Sometimes, the development or degree of dormancy changes during lifetime of the seed usually as a response to external conditions. Several types of dormancy exist and more than one type of dormancy can sometimes exist in a seed[3,9]. In nature, dormancy is broken gradually, by a particular environmental event, by microorganisms present in the soil or by digestive enzymes present in the soil or by digestive enzymes present in the alimentary canal of animals[8]. In m any species specific knowledge of seed dormancy is scarce, however, adaption of methods known to work for related species, duplication or simulation of natural conditions believed to influence dormancy are often effective[10].

In mechanical dormancy, embryo development is physically restricted due to a hard enclosing structure. Imbibitions of water may occur but radius is unable to split or penetrate its enclosure which is often part of the fruit[11]. Mechanical dormancy is common in several tropical and subtropical genera such as *Pterocarpus* (*P. indicus*, *P. angolensis* and so on), *Terminalia* (*T. brownie*, *T. mollis*, *T. tomentosa* and *T. superb*) and *Eucalyptus*[12]. Mechanical restriction to embryo growth maybe overcome by: gradual softening of pericarp to enable embryo expansion or by extracting the seeds from a mechanically restricting pericarp[11]. Mechanical scarification of seed coats by piercing, nicking, chipping, filling, burning or abrasion paper is one of the most ways of overcoming physical dormancy. In seed coat dormancy, the seed coat restricts oxygen and/or water permeating into the seed. Sometimes, dormancy is caused by inhibiting chemicals inside the seed. Seeds with seed coat dormancy can remain on/in the ground without germinating until the seed coat allows water and oxygen to enter the seed or eliminate the inhibiting chemicals. Seed coat dormancy is common in California lilac (*Ceanothus* sp.), Manzanita (*Arctostaphylos* sp.), Sumac (*Rhus* sp.) and members of the legume family. Scarification, hot water, dry heat, fire, acid and other chemicals, mulch and light are the methods used for breaking seed coat dormancy[13].

However, scarification, which involves seeds pretreatment with acid or hot water, can be used effectively for physically dominant seeds. They are frequently used where mechanical dormancy is combined with impermeable seed coat. Pre-treatment with acid has been successfully used to improve germination of *Terminalia bellirica*[14]. Hot water overcomes physical dormancy in leguminous seeds by creating tension which causes the macrosclerids layer to crack[13]. This method is most effective when seeds are submerged in hot water, not heated together with water.

Parkia biglobosa (Jacq) Benth belongs to the family Leguminosae (Fabaceae) is popularly known as African locust bean tree. *Parkia biglobosa* is a perennial deciduous tree with height ranging from 7-20 m. The crown is large and spread wide with branches low down on a stout bole, amber gum exudes from wounds and the bark is dark grey-brown, thick and fissured[15]. The pods are pink-brown to dark-brown when mature and may contain up to 30 seeds embedded in a yellow pericarp. The seeds have a hard testa and are large with mean weight of 0.26 g per seed with large cotyledons forming about 70% of their weights[16]. *Parkia biglobosa* has 2 types of seeds: reddish-dark and dark (black). They occur in every pod and ratio of their number varies from 1:20-1:5. The reddish-dark seed seems to have a thinner coat, probably a developmental factor and germinates earlier than the dark seeds[17]. Common names of *Parkia biglobosa* include; African locust beans (English), *Nere* (French), *Iru* (Yoruba), *Dorowa* (Hausa) and *Origili* (Igbo) of Nigeria. *Parkia biglobosa* is used as an ingredient for treating leprosy and hypertension. In the Gambia, the leaves and roots are used in preparing a lotion for sore eyes and decoction of the bark is used as baths for fever, hot mouth wash and toothache relief[18]. Fermentation products of *P. biglobosa* are of 2 types, 1 fermentation product is achieved with the addition of kuruu a local catalyst made from *Hibiscus sabdariffa* and potassium carbonate (kaun)[19,20] while the other does not involve the usage of this catalyst. The addition of the catalyst softens the bean seed faster and better. The soft fermented product is locally called *iru pete* while the hard one is called *iru woro* by the Yoruba. It is a major condiment in soup preparing in Nigeria and other sub-Saharan countries of Africa.

Prosopis africana is usually found in fallow land and various textured and latent soils. The pod is fleshy when immature but dries at maturity leaving the seeds loose 'rattling'. The hard seed coat is impermeable to water. This plant has several medicinal applications in Nigeria, Mali and other African countries. The fermented seed is used as soup condiment[21-25].

However, dormancy is a relatively important characteristic in the preservation of cultivated species seeds and especially important to maintain seed viability. It is also one of the greatest obstacles for the germplasm conservation of forest species, which frequently produce dormant seeds. Thus, this study was aimed at breaking seed dormancy in *Parkia biglobosa* and *Prosopis africana* using various methods with the view to determining the most efficient dormancy breaking methods.

MATERIALS AND METHODS

Study area: The experiment was carried out in the Department of Botany Laboratory, Lagos State University, Ojo, Lagos State, Nigeria under sterile conditions. Seeds of *Parkia biglobosa* and *Prosopis africana* were collected from the University of Agriculture, Abeokuta, Ogun State, Nigeria and experiment lasted for 3 months, between April-June, 2018.

Preliminary experiments: The preliminary experiment adopts the methods of Oluwole and Okusanya[26] with slight modification. Test for viability was carried out on the seeds and unviable seeds were discarded. The viable seeds were surfaced cleaned with ethanol to remove external agents like dirt and microorganisms. Petri dishes (90 mm) were lined with cotton wool and filter paper of the same size as the Petri dishes. Thus, a preliminary experiment was first carried out to know the actual germination time of the seeds of *Parkia biglobosa* and *Prosopis africana* when untreated. This serves as a template for the subsequent experiments.

Dormancy breaking experiments: The main dormancy experiment adopts the methods of Eira *et al.* [27] Oluwole and Okusanya[26] Eisvand *et al.*[28] and Cavalheiro *et al.*[11]. Three replicates each containing 15 viable seeds of *Parkia biglobosa* and *Prosopis africana*, respectively were used for this study. Each of the Petri dishes was labeled accordingly for each plant seeds.

Chemical scarification: Chemical scarification was done by using Hydrochloric Acid (HCl) and Sulphuric Acid (H_2SO_4). Different concentrations of the acids at 50, 75 and 95% with time of soaking at 5, 10 and 15 min at each concentration, respectively. 50% HCl: 50 mL of absolute HCl+ 50 mL of distilled water in a beaker. The seeds were soaked for 5, 10 and 15 min, respectively and stirred at intervals. The 75% HCl: 75 mL of absolute HCl plus 25 mL of distilled water in a baker. The seeds were soaked for 5, 10 and 15 min, respectively and stirred at intervals. The 95% HCl: 95 mL of absolute HCl plus 5 mL of distilled water in a baker. The seeds were soaked for 5, 10 and 15 min, respectively and stirred at intervals. The 100% HCl: Absolute HCl was poured in a beaker. The seeds were soaked for 5, 10 and 15 min, respectively and stirred at intervals. The same procedure was used for each concentration of Sulphuric acid and the seeds were soaked in the acids at the timing of 5, 10 and 15 min, respectively[26,28].

The acids were decanted after each treatment and the seeds washed with distilled water. The seeds were placed in the Petri dishes using moist filter paper and cotton wool as growth medium.

- **Hot water scarification:** The seeds were scalded in 100°C for 5, 10 and 15 min, respectively. Thus, the seeds were to cool before being placed in Petri dishes lined with moist cotton wool and filter paper[26,28]
- **Mechanical scarification:** Scissors was used in chipping the seeds coats of the seeds at 1 end. The chipped seeds were sown in Petri dishes lined with moist cotton wool and filter paper[11,26,27,28]
- **Cold treatment:** Seeds were soaked in distilled water for 24, 48 and 72 h, respectively. Using soil as a growth medium, the seeds were sown in bags containing loamy soil[11,26,27,28]

Data collection and data analysis: All the data collected from experiments were subjected to mean standard deviation.

RESULTS

The results of the study showed that seeds of *Parkia biglobosa* and *Prosopis africana* in which dormancy was broken using hot water showed null germination in the 3 replicates. Also, seeds of *Parkia biglobosa* and *Prosopis africana* treated with distilled water; that is cold treatment failed to record any germination.

Effects of chemical scarification on seed of *Parkia biglobosa* and *Prosopis africana*: Seeds of *Parkia biglobosa* and *Prosopis africana* soaked in 50 and 75% HCl failed to germinate, but showed darkened seed coat. Ruptured seed coats of *Parkia biglobosa* and burnt seeds of *Prosopis africana* were noticed in seeds treated with 95% HCl, but no germination occurred. The seed coats of seeds of *Parkia biglobosa* and *Prosopis africana* treated with concentrated HCl were burnt and ruptured beyond recognition (Table 1).

Seeds of *Parkia biglobosa* and *Prosopis africana* treated with the different concentrations of Sulphuric acid (H_2SO_4) showed germination. For seeds soaked in 50% H_2SO_4, *Parkia biglobosa* had its highest mean dormancy broken at 53.04±8.04 and *Prosopis africana* had its highest mean dormancy broken at 24.07±2.70 when soaked for 15 min. Soaking for 10 min yielded the lowest for *Parkia biglobosa* at 38.07±4.41 and *Prosopis africana* at 14.79±1.49 (Table 1).

For seeds soaked in 75% H_2SO_4, *Parkia biglobosa* had its highest dormancy broken when soaked for 15 min with its lowest at 10 min and *Prosopis africana* had its highest mean dormancy broken when soaked for 5 min with its lowest at 15 min (Table 1). On the contrary for 95% H_2SO_4, *Prosopis africana* had the highest mean germination at 5 minutes with the least germination at 10 minutes and at 15 minutes, *Parkia biglobosa* had the highest mean germination with its lowest mean dormancy broken at 10 minutes (Table 1).

At absolute concentration of H_2SO_4, *Parkia biglobosa* had its highest mean dormancy broken at 40.07±8.83 when soaked for 5 min with its lowest at 11.29±2.41 when soaked for 10 min and *Prosopis africana* had its highest mean dormancy broken when soaked for 15 min with its lowest at 5 min (Table 1).

Table 1: Effects chemical scarification on the seeds of *Parkia biglobosa* and *Prosopis africana*

Concentration of acids (%)	Seeds	5 min	10 min	15 min
HCl				
50	*Parkia biglobosa*	*	*	*
	Prosopis africana	*	*	*
75	*Parkia biglobosa*	*	*	*
	Prosopis africana	*	*	*
95	*Parkia biglobosa*	*	*	*
	Prosopis africana	*	*	*
100	*Parkia biglobosa*	*	*	*
	Prosopis africana	*	*	*
H_2SO_4				
50	*Parkia biglobosa*	40.14±6.39	38.07±4.41	53.64±8.04
	Prosopis africana	21.36±4.01	14.79±1.49	24.07±2.70
75	*Parkia biglobosa*	38.36±7.70	22.50±3.39	62.29±7.61
	Prosopis africana	10.57±2.40	9.43±2.29	6.39±1.77
95	*Parkia biglobosa*	34.71±2.80	39.57±4.52	63.43±4.58
	Prosopis africana	67.00±4.57	22.90±3.52	66.21±8.14
100	*Parkia biglobosa*	40.07±8.83	11.29±2.40	25.50±4.70
	Prosopis africana	13.14±2.50	22.86±3.51	48.71±7.10

*No germination or growth observed

Table 2: Effects of mechanical scarification on the seeds of *Parkia biglobosa* and *Prosopis africana*

Methods	Seeds	Mean germination (%)
Mechanical scarification	*Parkia biglobosa*	60.21±5.08
	Prosopis africana	72.80±8.52
Control	*Parkia biglobosa*	37.79±5.14
(soil as growth medium)	*Prosopis africana*	17.93±3.74

Effects of mechanical scarification on seeds of *Parkia biglobosa* and *Prosopis africana:* Seeds of *Parkia biglobosa* and *Prosopis africana* treated with mechanical scarification showed germination, with *Prosopis africana* having highest mean dormancy broken at 72.80±8.52 while P*arkia biglobosa* had 60.21±5.08. Mean dormancy broken of *P. biglobosa* was least at 37.79±5.14 and *P. africana* at 17.93±3.74 when soil was used as a medium (Table 2).

DISCUSSION

Seeds of *Parkia biglobosa* soaked in 95% of H_2SO_4 for 15 min had the highest mean dormancy broken followed by those soaked for 5 min while, those soaked for 10 min had the least (Table 1). This finding was contrary to Aliero[29] when reported highest germination for seeds soaked in concentration H_2SO_4 for 3 min. However, it reported that none of the seeds germinated after soaking for 5 min. The finding conformed to findings of another study[5] when they reported efficient dormancy breakage in the seeds *Ormosia arborea* treated with sulphuric acid. Thus, the chemical treatments for dormancy breaking tegumentary seed were efficient because they promoted the rupture of the impermeable layer in distributing pores in the integument when the sulphuric acid used. Thus, enhancing the water absorption by seed and triggering the germination process[30].

Mechanical scarification gave *Prosopis africana* its highest mean percentage dormancy broken at 72.80 (Table 2), this agreed with the findings of Rolston[31] who reported that mechanical scarification showed an efficient dormancy breaking method to provoke germination in *Astragalus siliquosus* seeds, chemical scarification of *Prosopis africana* with H_2SO_4 having its highest dormancy broken for 5 min in 95% concentration of the acid (Table 1). This, was supported by Oluwole and Okusanya [26], when they reported that the acid solution may have weaken the hard shell by reacting with the fibrous substance in the shell probably via an oxidation-reduction process. Thus, the weakened shell then becomes more permeable to water thus increasing both the total germination (%) and the rate of germination. However, Table 1 showed that seeds soaked for 15 min for *Prosopis africana* have the highest germination which is in accordance with the findings of Ajiboye and Agboola[32] on *Prosopis africana* and *Dalium guinenesis* seeds. They reported that seeds of *Prosopis africana* had highest germination after soaking in concentrated H_2SO_4 for 15 min. Thus, this enhanced the germination (%) and boost crop production[26].

Also, several researchers have demonstrated that chemical scarification can be used to break dormancy in various plants such as *Ceiba petandra*, *Cercocarpus montamis*, *Centrosema pubescens*, *Haranyana madagascariensis*, *Albezia lebbeck*, *Tamarindas indica* and *Parkia biglobosa*[33,34]. Hard seed coats have been found to be impervious to water and gases, the proper enzymatic actions and proper mobilization of food for growth due to the impervious nature of the seed coats.

This research showed that, *Parkia biglobosa* had higher germination rates than *Prosopis africana* except when *Prosopis africana* was scarified at 95% acids concentration for 5 min (Table 1). The higher yields recorded for *Parkia biglobosa* may be as a result of its observable seed size differences and this may be due to genetic attributes, genetic constitutions and size of the embryo [29,21] considering the fact they are from the same family, that is, Fabaceae. However, several studies have shown that scarification methods improved germination in *Parkia nitida* Miq. seeds[5] more than 74%.

Seed of *Parkia biglobosa* and *Prosopis africana* sown in loamy soil yielded mean germination ranging from 37.79-17.93, respectively. This may be due to the interaction of more external factors such as the soil temperature, soil texture, soil porosity and organisms present in the soil[35]. Though, seed dormancy can be broken by natural events like bush fire and activities of some soil microorganisms.

CONCLUSION

It could be concluded from the results that seeds of *Parkia biglobosa* and *Prosopis africana* are naturally dormant and their dormancy is due to their tough, hard and impervious seed coats. This showed that the seeds have seed coat dormancy. The dormancy was terminated using chemical scarification method which involved soaking the seeds in concentrated H_2SO_4 at different intervals. Also, dormancy was also broken through mechanical scarification using scissors to chip the seeds at one end.

It is imperative to recommend that germination of seeds of *Parkia biglobosa* and *Prosopis africana* should employ artificial methods of dormancy breakage using any of the identified effective methods.

SIGNIFICANCE STATEMENT

This study discovers that circumventing the menace of seed dormancy in dormant seeds of *Parkia biglobosa* and *Prosopis africana* can be beneficial to the farmers especially in Nigeria, who are faced with challenge of growing the crop. This study will help the researcher to uncover the critical areas of some tropical plant seeds' dormancy that many researchers were not able to explore. Thus a new theory on possible ways of circumventing the menace posited by seed dormancy may be arrived at.

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